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CLAIMS

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(57) [Claim(s)]
[Claim 1] The fuel cell which generates electricity by the reaction of the hydrogen gas and oxygen gas which were supplied from the source of hydrogen gas supply, and the oxygen gas source of supply, The hydrogen gas circuit and oxygen gas circuit which supply again the unreacted above-mentioned hydrogen gas and the oxygen gas which were discharged from this fuel cell to the above-mentioned fuel cell, Have the hydrogen gas circulating pump and oxygen gas circulating pump which were formed in each gas circuit, and it changes. It is the fuel cell powered vehicle which drives a drive motor with the electrical and electric equipment generated with the above-mentioned fuel cell. After suspending supply of the hydrogen gas from the above-mentioned source of hydrogen gas supply, and an oxygen gas source of supply, and oxygen gas at the time of an actuation halt of the above-mentioned fuel cell, by electrical and electric equipment generated by the reaction of the residual hydrogen gas and residual oxygen gas which remain to the above-mentioned fuel cell The fuel cell powered vehicle characterized by being what operates the gas circulating pump by the side of the gas which has the exocytosis of the generation water by the reaction of the above-mentioned ring main at least among the above-mentioned ring main circulating pumps.
[Claim 2] The fuel cell powered vehicle according to claim 1 characterized by being what also operates electronic autoparts other than this ring main circulating pump with the above-mentioned ring main circulating pump carried in the automobile by electrical and electric equipment generated by the reaction of the residual hydrogen gas and residual oxygen gas which remain to the above-mentioned fuel cell after suspending supply of the hydrogen gas from the above-mentioned source of hydrogen gas supply, and an oxygen gas source of supply, and oxygen gas.
[Claim 3] The fuel cell powered vehicle according to claim 1 characterized by being what stops actuation of the gas circulating pump made to operate by electrical and electric equipment generated by the reaction of both the above-mentioned residual gas when the output of the above-mentioned fuel cell becomes below default value, or when the hydrogen gas pressure or oxygen gas pressure in the above-mentioned fuel cell becomes below default value.
[Claim 4] The fuel cell powered vehicle according to claim 2 characterized by being what stops actuation of electronic autoparts other than the above-mentioned ring main circulating pump and this ring main circulating pump when the output of the above-mentioned fuel cell becomes below default value, or when the hydrogen gas pressure or oxygen gas pressure in the above-mentioned fuel cell becomes below default value.
[Claim 5] The fuel cell powered vehicle according to claim 2 or 4 with which electronic autoparts other than the above-mentioned ring main circulating pump are characterized by consisting of at least one of lighting lamps, an indoor ventilator, or air cleaners.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention is equipped with the fuel cell which hydrogen gas and oxygen gas are made to react and is generated, and relates to the fuel cell powered vehicle driven with the electrical and electric equipment generated with this fuel cell.
[0002]
[Description of the Prior Art] For example, the fuel cell which generates electricity by making hydrogen and oxygen react to a U.S. Pat. No. 5,047,298 specification is indicated. Moreover, JP,51-4717,A is equipped with the fuel cell which generates electricity by making such hydrogen and oxygen react, and the fuel cell powered vehicle drives a drive motor with the electrical and electric equipment generated with this fuel cell, and it runs is indicated.
[0003] For example, the PEM mold fuel cell using the proton exchange film as a fuel cell like the above is known. An oxyecoia room and a hydrogen room are prepared on both sides of the proton exchange film, this fuel cell supplies humidification oxygen gas and humidification hydrogen gas to both **, and it goes into an oxyecoia room through the proton exchange film, and the hydrogen ion ionized at the hydrogen room makes hydrogen and oxygen react, and generates electricity in this oxyecoia room.
[0004] As conventionally shown in drawing 11 and drawing 12, such a fuel cell is carried out every width, and is arranged in the automobile. Namely, a fuel cell 2 is equipped with the generation-of-electrical-energy section 6 which accumulated two or more generation-of-electrical-energy cels equipped with the humidification section 4 which humidifies oxygen gas and hydrogen gas, and the above-mentioned proton exchange film, an oxyecoia room and a hydrogen room, and changes. The oxygen gas path 20 (the supply side path 22 and discharge side path 24) which supplies and discharges oxygen gas to the oxyecoia room of each generation-of-electrical-energy cel, In the hydrogen room of each generation-of-electrical-energy cel, hydrogen gas The cooling water path 36 (the supply side path 32 and discharge side path 34) which supplies and discharges the cooling water which cools the hydrogen gas passageway 30 (the supply side path 26 and discharge side path 28) and each generation-of-electrical-energy cel which are supplied and discharged is extended and arranged in the direction of a pile of each above-mentioned generation-of-electrical-energy cel (longitudinal direction in drawing), respectively. This fuel cell 2 is carried out every width so that the direction of a pile of each of that cel may become horizontally (longitudinal direction in drawing), and it is arranged in an automobile, therefore the oxygen gas path 20, the hydrogen gas passageway 30, and the cooling water path 36 serve as a mode all prolonged horizontally.
[0005]
[Problem(s) to be Solved by the Invention] By the way, since hydrogen and oxygen are made to react, water may be generated by the reaction, therefore in the case of the PEM mold fuel cell using the proton exchange film like the above, the generation water may adhere to the proton exchange film, and trouble may produce the fuel cell like the above in a generation of electrical energy. Moreover, in the case of the PEM mold fuel cell using such proton exchange film, the moisture which it is necessary to make the hydrogen gas and oxygen gas contain moisture in order to make hydrogen gas and oxygen gas react, and is contained in the hydrogen gas and oxygen gas may adhere to the above-mentioned proton exchange film, and trouble may arise in a generation of electrical energy.
[0006] Furthermore, at the time of fuel cell actuation, since hydrogen gas and oxygen gas are flowing, the inside of a fuel cell Although the moisture contained in generation water and the above-mentioned hydrogen gas by the above-mentioned reaction, or oxygen gas is discharged to some extent by the flow of the hydrogen gas and oxygen gas to the fuel cell exterior through the above-mentioned hydrogen gas passageway and an oxygen gas path with this flow At the time of an actuation halt of a fuel cell, it is already stopped by the flow of the above-mentioned hydrogen gas or oxygen gas. Under the condition that the flow stopped, while the residual hydrogen gas and residual oxygen gas in a fuel cell are for a while, it continues reacting. Therefore, the moisture contained in the water generated by the reaction of the residual hydrogen gas and residual oxygen gas, or those residual gas It cannot discharge outside by the flow of hydrogen gas and oxygen gas like [at the time of actuation of the above-mentioned fuel cell], they may adhere to the proton exchange film, therefore trouble may be caused to a generation of electrical energy by this attached groundwater at the time of subsequent starting.
[0007] What is depended on produced water is remarkable, and since it reacts as mentioned above in an oxyecoia room and water is generated, when it is the above-mentioned PEM mold fuel cell, when especially the problem of the attached groundwater to the above-mentioned proton exchange film solves the problem of the above-mentioned attached groundwater, it is important for it to solve adhesion of the water generated especially at this oxyecoia

room side.
[0008] The purpose of this invention is to offer the fuel cell powered vehicle which can prevent the trouble resulting from the generation water by the reaction of hydrogen gas and oxygen gas in view of the above-mentioned situation.

[0009]
[Means for Solving the Problem] The fuel cell which generates electricity by the reaction of the hydrogen gas and oxygen gas which were supplied from the source of hydrogen gas supply, and the oxygen gas source of supply in order that the fuel cell powered vehicle concerning this invention may attain the above-mentioned purpose, The hydrogen gas circuit and oxygen gas circuit which supply again the unreacted above-mentioned hydrogen gas and the oxygen gas which were discharged from this fuel cell to the above-mentioned fuel cell, Have the hydrogen gas circulating pump and oxygen gas circulating pump which were formed in each gas circuit, and it changes. It is the fuel cell powered vehicle which drives a drive motor with the electrical and electric equipment generated with the above-mentioned fuel cell. After suspending supply of the hydrogen gas from the above-mentioned source of hydrogen gas supply, and an oxygen gas source of supply, and oxygen gas at the time of an actuation halt of the above-mentioned fuel cell, by electrical and electric equipment generated by the reaction of the residual hydrogen gas and residual oxygen gas which remain to the above-mentioned fuel cell It is characterized by being what operates the gas circulating pump by the side of the gas which has the exocytosis of the generation water by the reaction of the above-mentioned ring main at least among the above-mentioned ring main circulating pumps.
[0010] In the fuel cell powered vehicle concerning this invention, after suspending supply of the hydrogen gas from the above-mentioned source of hydrogen gas supply, and an oxygen gas source of supply, and oxygen gas, it is the electrical and electric equipment generated by the reaction of the residual hydrogen gas and residual oxygen gas which remain to the above-mentioned fuel cell, and can constitute as what also operates electronic autoparts other than this ring main circulating pump with the above-mentioned ring main circulating pump carried in the automobile.
[0011] Moreover, when the output of the above-mentioned fuel cell becomes below default value, or when the hydrogen gas pressure or oxygen gas pressure in the above-mentioned fuel cell becomes below default value, it can constitute as what stops actuation of the gas circulating pump made to operate by electrical and electric equipment generated by the reaction of both the above-mentioned residual gas.
[0012] Moreover, when the output of the above-mentioned fuel cell becomes below default value, or when the hydrogen gas pressure or oxygen gas pressure in the above-mentioned fuel cell becomes below default value, it can constitute as what stops actuation of electronic autoparts other than the above-mentioned ring main circulating pump and this ring main circulating pump.
[0013] Moreover, as electronic autoparts other than the above-mentioned ring main circulating pump, lighting lamps, an indoor ventilator, or an air cleaner can be mentioned.
[0014]
[Function and Effect(s) of the Invention] The fuel cell powered vehicle concerning this invention as mentioned above at the time of an actuation halt of a fuel cell Since the gas circulating pump by the side of the gas which has the exocytosis of the generation water by the reaction of the above-mentioned ring main at least among ring main circulating pumps by electrical and electric equipment generated by the reaction of residual hydrogen gas and residual oxygen gas (it is an oxygen gas circulating pump in the case of the above-mentioned PEM mold fuel cell) is operated The flow of the residual gas which has produced water exocytosis is formed, therefore the generation water by the residual-gas reaction can be made to discharge out of a fuel cell by the flow of this residual gas. Trouble generating by adhesion on the proton exchange film of the produced water can be controlled the case of the trouble by adhesion of the residual-gas produced water within a fuel cell, for example, a PEM mold fuel cell. Trouble generating by adhesion of the residual-gas produced water especially at the time of restart of a fuel cell can be prevented.
[0015] Moreover, a deployment of the surplus electrical and electric equipment by this residual-gas reaction can be aimed at by operating not only a ring main circulating pump but electronic autoparts other than these with the electrical and electric equipment by the above-mentioned residual-gas reaction.
[0016] Moreover, when the output of a fuel cell or the gas pressure in a fuel cell becomes below default value, those actuation halt can be appropriately performed by stopping actuation of the above-mentioned gas circulating pump or electronic autoparts.
[0017] Moreover, when making it operate as the above-mentioned electronic autoparts during a halt of an automobile called lighting lamps, an indoor ventilator, or an air cleaner chooses the need or an effective thing, use of the above-mentioned dump power can be made much more effective.
[0018]
[Example] Hereafter, the example of this invention is explained to a detail, referring to a drawing.
[0019] Drawing showing the flow of the hydrogen gas which is reactant gas in drawing showing the basic configuration of the fuel cell system in one example of the fuel cell powered vehicle which <basic configuration of fuel cell system> drawing 1 requires for this invention, drawing in which drawing 2 shows the fuel cell in drawing 1 , and the fuel cell which shows drawing 3 to drawing 2 , oxygen gas, and cooling water, and drawing 4 are the detail sectional views showing the flow of the oxygen gas in the fuel cell shown in drawing 2 .
[0020] First, a fuel cell is explained, referring to drawing 2 , and 3 and 4. In this example, the PEM mold fuel cell which the hydrogen gas and oxygen gas which used the proton exchange film as fuel cells are made to react, and is generated is used.

[0021] As shown in drawing 2 , this fuel cell 2 is equipped with the humidification section 4 and the generation-of-electrical-energy section 6, humidifies the oxygen gas and the hydrogen gas which are reactant gas with the cooling water using pure water in the humidification section 4, makes these oxygen gas and hydrogen gas that were humidified react in the generation-of-electrical-energy section 6, generates them, and it is constituted so that the generation-of-electrical-energy section 6 which heat of reaction produces by the reaction of a parenthesis may be cooled by the above-mentioned cooling water.
[0022] The above-mentioned humidification section 4 accumulates two or more humidification cels, and changes, and oxygen gas, hydrogen gas, and cooling water are humidified in each cel in each cel as sequential. Humidification in each cel is performed by contacting oxygen gas and hydrogen gas to cooling water through the poly membrane which passes moisture, and making oxygen gas and hydrogen gas contain the moisture of maximum vapor tension.
[0023] As shown in drawing 4 , two or more generation-of-electrical-energy cels 8 are accumulated, and the above-mentioned generation-of-electrical-energy section 6 changes, and the oxygen gas and hydrogen gas which were humidified in the above-mentioned humidification section 4 react each cel 8 in each cel 8 as sequential, and it generates electricity. Each cel 8 is equipped with the proton exchange film 10 which lets only a hydrogen ion pass, the hydrogen room 12 and oxyecoia room 14 which were divided with this proton exchange film 10, and the hydrogen lateral electrode 16 and the oxygen lateral electrode 18 prepared in the above-mentioned proton exchange film 10, and changes.
[0024] The oxygen gas path 20 which extends in the direction of a pile of each generation-of-electrical-energy cel 8 is established in the generation-of-electrical-energy section 6. This oxygen gas path 20 is equipped with the supply side path 22 which extends in the direction of a pile of each cel 8, and the discharge side path 24, supplies oxygen gas to the oxyecoia room 14 of each cel 8 from the supply side path 22, and discharges unreacted oxygen gas through the discharge side path 24 from the oxyecoia room 14 of each cel 8. Moreover, this oxygen gas path 20 and the hydrogen gas passageway which was constituted similarly and which is not illustrated are prepared in the generation-of-electrical-energy section 6. It has the above-mentioned oxygen gas path 20, the supply side path which extends in the direction of a pile of each cel 8 similarly, and a discharge side path, and this hydrogen gas passageway also discharges unreacted hydrogen gas through a discharge side path from the hydrogen room 12 of each cel, while supplying hydrogen gas to the hydrogen room 12 of each cel from a supply side path. Furthermore, the cooling water path which is not illustrated is established in the generation-of-electrical-energy section 6, this cooling water path is also equipped with the above-mentioned oxygen gas path 20, the supply side path which extends in the direction of a pile of each cel 8 similarly, and a discharge side path, and while supplying cooling water to the cooling water chamber 25 formed between each cel 8 from the supply side path, cooling water is discharged through a discharge side path from each cooling water chamber 25.
[0025] The generation-of-electrical-energy mechanism in each above-mentioned generation-of-electrical-energy cel 8 is as follows. That is, the humidification hydrogen supplied to the hydrogen room 12 of each cel 8 is ionized under the hydrogen lateral electrode 16, this hydrogen ion goes into an oxyecoia room 14 through the proton exchange film, hydrogen and oxygen react under the oxygen lateral electrode 18 in this oxyecoia room 14, while generating electricity by this reaction, water is generated, and this generation water is discharged by the flow of unreacted oxygen gas from the discharge side usual route 24 of oxygen with unreacted oxygen gas.
[0026] The path and flow of the oxygen gas in the above-mentioned humidification section 4 and the generation-of-electrical-energy section 6, hydrogen gas, and cooling water are shown in drawing 3 . It has extended in the direction of a pile of each cel 8 like illustration like [the hydrogen gas passageway 30 which is equipped with the supply side path 26 and the discharge side path 28, and changes, and the cooling water path 36 which is equipped with the supply side path 32 and the discharge side path 34, and changes] the above-mentioned oxygen gas path 20. Moreover, a fuel cell 2 is arranged considering the direction of a pile of each cel 8 as a vertical direction, the humidification section 4 is located in the upper part of the generation-of-electrical-energy section 6, and cooling water is constituted so that it may supply from the bottom and may discharge upwards, so that the oxygen gas path 20, the hydrogen gas passageway 30, and the cooling water path 36 may all extend in the vertical direction, oxygen gas and hydrogen gas may supply from a top and it may discharge downward.
[0027] As mentioned above, a fuel cell 2 is arranged every length so that the direction where the hydrogen gas passageway 30 which passes along the generation-of-electrical-energy section 6, and the oxygen gas path 20 extend may become in the vertical direction. By supplying hydrogen gas and oxygen gas to the above-mentioned hydrogen gas passageway 30 and the oxygen gas path 20 from each upper part, and constituting so that unreacted hydrogen gas and oxygen gas may be discharged from the lower part The above-mentioned hydrogen gas and oxygen gas will go caudad, and will flow the inside of the hydrogen gas passageway 30 prolonged in the vertical direction, and the oxygen gas path 20. Therefore, gravity can work to that eject direction to the moisture discharged by the flow of hydrogen gas and oxygen gas, discharge of moisture is promoted by this gravity, eccritic improvement in the moisture contained in produced water, hydrogen gas, and oxygen gas can be achieved, and generating of the trouble by water adhesion within a fuel cell, for example, the trouble by water adhesion on the proton exchange film in the case of a PEM mold fuel cell, can be controlled.
[0028] Next, the fuel cell system in the automobile using an above-mentioned fuel cell is explained, referring to drawing 1 . The fuel cell system of illustration is equipped with two fuel cells 2, oxygen gas, hydrogen gas, and cooling water are supplied to both the fuel cells 2 in juxtaposition, and the electrical and electric equipment generated with each fuel cell 2 is taken out in serial.
[0029] Oxygen gas itself is supplied to each fuel cell 2 through the oxygen gas supply way 52 from the high-

pressure-oxygen bomb 50 which is an oxygen gas source of supply. Moreover, from each fuel cell 2, unreacted oxygen gas is discharged through the oxygen gas exhaust passage 54, it connects with the above-mentioned oxygen gas supply way 52 in an A point, the oxygen gas circuit 56 is formed in the part from the above-mentioned A point to a fuel cell 2 among the oxygen gas path in each fuel cell 2, the above-mentioned oxygen gas exhaust passage 54, and the above-mentioned oxygen gas supply way 52, and the above-mentioned unreacted oxygen gas is made to circulate through this oxygen gas exhaust passage 54 through this oxygen gas circuit 56.

[0030] Solenoid-valve SV1' which is a former bulb sequentially from the oxygen gas source-of-supply 50 side, pressure regulator PR' which keeps supply oxygen gas pressure constant, solenoid-valve SV3' prepared in the fork road, pressure-sensor PS1', and solenoid-valve SV2' which is an inlet-port bulb are prepared in the above-mentioned oxygen gas supply way 52, and flow rate sensor FS', solenoid-valve SV4' which is a circuit closing motion bulb, and pressure-sensor PS2' are prepared in the oxygen gas circuit 56 combination part. Solenoid-valve SV5' which is the purge valve prepared in the fork road, the water trap container (water separator) 58, oxygen gas circulating-pump GP', and deionization filter DIF' are prepared in the above-mentioned oxygen gas exhaust passage 54.

[0031] Moreover, hydrogen gas itself is supplied to each fuel cell 2 through the hydrogen gas supply way 62 from the hydrogen storing metal alloy 60 which carried out occlusion of the hydrogen which is a source of hydrogen gas supply. Moreover, from each fuel cell 2, unreacted hydrogen gas is discharged through the hydrogen gas exhaust passage 64, it connects with the above-mentioned hydrogen gas supply way 62 in a B point, the hydrogen gas circuit 66 is formed in the part from the above-mentioned B point to a fuel cell 2 among the hydrogen gas passageway in each fuel cell 2, the above-mentioned hydrogen gas exhaust passage 64, and the above-mentioned hydrogen gas supply way 62, and this hydrogen gas exhaust passage 64 is made to circulate through the above-mentioned unreacted hydrogen gas through this hydrogen gas circuit 66.

[0032] The solenoid valve SV 2 which are pressure regulator PR which keep constant the solenoid valve SV 1 which is a former bulb sequentially from the source 60 side of hydrogen gas supply, and supply hydrogen gas pressure, the solenoid valve SV 3 prepared in the fork road, pressure-sensor PS1, and an inlet-port bulb is formed in the above-mentioned hydrogen gas supply way 62, and the solenoid valve SV 4 which are flow rate sensor FS and a circuit closing motion bulb, and pressure-sensor PS2 are formed in the hydrogen gas circuit 66 combination part. The solenoid valve SV 5 which is a purge valve prepared in the fork road, the water trap container (water separator) 68, the hydrogen gas circulating pump GP, and the deionization filter DIF are formed in the above-mentioned hydrogen gas exhaust passage 64. Moreover, in case a fork road is prepared between the above-mentioned source 60 of hydrogen gas supply, and a solenoid valve SV 1, the leak bulb RV, the manual bulb MV1, and the quick connector QC are formed and occlusion of the hydrogen is carried out to a hydrogen storing metal alloy 60, a hydrogen bomb (not shown) is connected to this quick connector QC.

[0033] Moreover, the cooling water circuit 70 is established in each fuel cell 2. This cooling water circuit 70 changes including the above-mentioned cooling water path which is not illustrated in a fuel cell 2, and the conductivity sensor CS which detects the conductivity of the above-mentioned water trap container 58, cooling water circulating-pump WP, a cross valve TV, the radiator RD for cooling water heat dissipation, this radiator RD, the bypass BP formed in juxtaposition and the deionization filter DIF, and cooling water is formed in this cooling water circuit 70.

[0034] Moreover, various kinds of electronic autoparts (the above-mentioned gas circulating pump GP and GP' are also included) are connected to each above-mentioned fuel cell 2 through the electric power supply switch which is not illustrated while a drive motor 72 is connected to the electric wire which voltage sensor VS which detects the output voltage of each generation-of-electrical-energy cel 8 of the generation-of-electrical-energy section 6 was prepared, and connected both the fuel cells 2 to the serial through the electric power supply switch SW1.

[0035] Moreover, in the above-mentioned system, the solenoid valve SV 6 like illustration, SV6', SV7, the manual bulb MV2, MV2', MV3', and the auto bulb AV1 are formed.

[0036] Like the above, in the constituted system, except for a solenoid valve SV 4 and SV4', other all solenoid valves, manual bulbs, auto bulbs, and leak bulbs are closed, and a drive halt of each circulating pump GP and GP'WP is carried out, and Kaisei of the switch SW1 of a drive motor 72 and the switch of various electronic autoparts is carried out at the time of the usual fuel cell actuation halt.

[0037] moreover, at the time of the usual fuel cell actuation (at the time of operation) Carry out Kaisei of solenoid valves SV1 and SV2, SV1', and SV2', and hydrogen gas and the oxygen gas circulating pump GP, and GP' are operated. They are circulated while supplying oxygen gas and hydrogen gas to each fuel cell 2 (from oxygen gas and the sources 50 and 60 of hydrogen gas supply, oxygen gas and hydrogen gas are newly supplied only for the amount consumed by the reaction). Moreover, operate cooling water circulating-pump WP and a fuel cell 2 is made to circulate through cooling water. While having, and generation of electrical energy with each fuel cell 2 and cooling of each fuel cell 2 being performed by the above-mentioned mechanism, closing a switch SW1 further and driving a drive motor 72 with the generated electrical and electric equipment, the switch which a **** does not illustrate is closed and power is supplied to various electronic autoparts.

[0038] It explains referring to drawing 5 R> 5 about <the actuation shutdown procedure of a fuel cell system>, next the actuation shutdown procedure of the above-mentioned fuel cell system. This actuation halt is performed by the procedure in which the generation water by the reaction of the residual gas in a fuel cell 2 is eliminated good, and a deployment of the dump power by the reaction of that residual gas can be aimed at.

[0039] First, the electric power supply switch SW1 from a fuel cell to an external load, i.e., the electric power supply

switch to a drive motor 72, the electric power supply switch to various above-mentioned electronic autoparts, etc. are turned OFF by P1, a bulb SV 1 and SV1' are closed by P2 after that, and supply of the hydrogen gas from the source 60 of hydrogen gas supply and the oxygen gas source of supply 50 to a fuel cell 2 and oxygen gas is suspended.

[0040] However, even if it suspends supply of hydrogen gas and oxygen gas to this appearance, in order that hydrogen gas and oxygen gas may remain in the fuel cell 2 and those residual gas may continue reacting within the peach fuel cell 2 after that, the water generated by it will adhere to the proton exchange film 10, and the attainment to the proton exchange film of reactant gas will be barred at the time of a reboot.

[0041] Then, after closing the above-mentioned bulb SV 1 and SV1', in P3, the hydrogen gas circulating pump GP and oxygen gas circulating-pump GP' are operated using the power generated by the reaction of the residual gas in the above-mentioned fuel cell 2. This actuation is performed by closing the ring main circulating pump GP and the electric power supply switch to GP'. By the flow of this hydrogen gas and oxygen gas, the water which hydrogen gas and oxygen gas circulated through the inside of the hydrogen gas circuit 66 and the oxygen gas circuit 56 also during the reaction of residual gas, therefore was generated by the moisture in that residual gas and the reaction of residual gas by this is discharged outside good, and can prevent water adhesion on the proton exchange film after a fuel cell actuation halt.

[0042] Moreover, in P4, those gas circulating pumps GP and predetermined electronic autoparts other than GP' are operated using the above-mentioned gas circulating pump GP and the dump power generated by the reaction of residual gas with actuation of GP'. This actuation is performed by closing the electric power supply switch to the above-mentioned predetermined electronic autoparts. It can be desirable for making it operate during a stop of an automobile to operate the need or effective electronic autoparts in this electronic-autoparts actuation, and that appearance can operate suitably lighting lamps, such as a step lamp and a hazard lamp, a vehicle indoor ventilator, or an air cleaner as electronic autoparts, for example. In addition, for example, when [that whenever / vehicle room air temperature / is higher than outside air temperature and] whenever [vehicle room air temperature] is higher than laying temperature, it can be made to operate for the purpose of rise prevention whenever [vehicle room air temperature / of a summer] in actuation of the above-mentioned vehicle indoor ventilator.

[0043] Then, if it detects that the output power or residual gas pressure of a fuel cell 2 became below a predetermined value by P5, while regarding it as that to which the amount of residual reactant gas decreased enough and stopping the drive of the above-mentioned gas circulating pump GP and GP' by P6, the drive of the above-mentioned electronic autoparts is stopped, a bulb SV 2 and SV2' will be closed by P7, and a fuel cell system will be stopped. The output voltage of the above-mentioned fuel cell 2 may be an electrical potential difference (total of the generation-of-electrical-energy electrical potential difference of two or more generation-of-electrical-energy cels which constitute one fuel cell) of fuel cell 2 unit, and may be an electrical potential difference of each generation-of-electrical-energy cel unit. Those electrical potential differences are detected by voltage sensor VS prepared in the above-mentioned fuel cell 2. Moreover, residual hydrogen gas pressure, residual oxygen gas pressure, or any of the residual gas pressure of those both sides is sufficient as the above-mentioned residual gas pressure, and it can detect those residual gas pressure by above-mentioned pressure-sensor PS2 and PS2'.

[0044] As mentioned above, after an actuation halt of a fuel cell, i.e., the supply interruption of the reactant gas to a fuel cell, since it constituted so that the ring main circulating pump GP and GP' might be driven using the electrical and electric equipment generated by the reaction of residual gas, the water and the residual-gas content moisture which were generated by the reaction of residual gas can be discharged from a fuel cell 2 good by the flow of the residual gas, and the trouble at the time of starting by this residual-gas produced water etc. can be prevented.

[0045] Moreover, since it constituted so that making it operate during an automobile stop as mentioned above to having made the dump power leak with the dump power generated by the residual-gas reaction conventionally might drive the need or effective electronic autoparts, a deployment of the dump power can be aimed at.

[0046] <The activation procedure of a fuel cell system>, next the activation procedure of the above-mentioned fuel cell system are explained referring to drawing 6 - drawing 9 . In case the above-mentioned fuel cell system is started, a supply-gas-pressure check besides the check of the attached groundwater in the above-mentioned fuel cell, a gas leak check, and a short circuit check are performed automatically, respectively, if altogether satisfactory, it will shift to usual actuation of a fuel cell system, and starting will be suspended if un-arranging is in either. Since starting is automatically suspended when this performs automatically each above-mentioned check difficult for the regular user which does not have a know how and un-arranging exists, implementation of insurance transit is achieved.

[0047] The start switch (not shown) (except for the ring main circulating pump GP and the electric power supply switch to GP') which supplies power to a fuel cell system control circuit from the usual dc-battery which is not probably illustrated by Q1 is made to turn on in starting of the above-mentioned fuel cell system, as shown in drawing 6 . Then, a bulb SV 1 and SV1' are made open by Q2, and supply gas pressure is checked by pressure-sensor PS1 and PS1'. When supply gas pressure is abnormalities, starting is suspended, when normal, a bulb SV 2 and SV2' are made open by Q4, and oxygen gas and hydrogen gas are supplied to a fuel cell 2. And starting will be suspended, if the gas leak in a fuel cell 2 is checked by Q5 and there is a gas leak. If there is nothing, will perform a short circuit check by Q6, and starting will be suspended if there is a short circuit. If there is nothing, will detect a generation-of-electrical-energy electrical potential difference, a current, and temperature by Q7, and close the gas circulating pump GP and the electric power supply switch to GP' by Q8, and the ring main circulating pump GP and GP' are operated. A generation-of-electrical-energy electrical potential difference is checked by Q9, if an electrical

potential difference is unusual, starting will be suspended, and if there is nothing, all the checks at the time of starting will shift to the usual actuation which actuation is continued [actuation] as it is by normal, and makes a drive motor 72 electric power supply switch [SW1] off.
[0048] Next, each above-mentioned check is explained to a detail. First, the procedure shown in drawing 7 performs a supply-gas-pressure check. Drawing 7 is the check procedure of supply hydrogen gas pressure, and is performed like [a supply oxygen-gas-pressure check] this. First, a bulb SV 1 is opened by R1. At this time, the bulb SV 2 is still closed, therefore to the bulb SV 2, hydrogen gas is supplied from the source 50 of hydrogen gas supply, and the downstream is adjusted to gas pressure predetermined by those pressure regulator PR from pressure regulator PR. Therefore, a supply-gas-pressure check (this gas pressure check is a check of pressure regulator PR after all) is performed by detecting a pressure by pressure-sensor PS1 prepared between pressure regulator PR and a bulb SV 2 in this condition. Detection gas pressure progresses to R9 R2 because supply gas pressure is normal at the time of below default value (set based on the gas pressure which should be adjusted by pressure regulator PR), and a bulb SV 2 is opened and it progresses to the following process (Q5 of drawing 6). From default value, progress to R3 in size at the time of the abnormalities in gas pressure, and detection gas pressure closes the above-mentioned bulb SV 1 there, opens a bulb SV 3 by R4, and emits hydrogen gas into atmospheric air. In R5, detect gas pressure by pressure-sensor PS1, and it judges whether detection gas pressure went down below to default value. It judges whether when having continued opening SV3 until it fell below in default value, and becoming below default value, SV3 was closed by R6, and the count of activation to the above R1-R6 became the count of a convention in R7, if it has not reached, it returns to R1, and the step to R1-R6 is performed again. And if this step to R1-R6 is repeated and the detection gas pressure of pressure-sensor PS1 becomes below default value in R2 by that middle, it will progress to R9. If the count of activation of the step to R1-R6 becomes the count of a convention, without the detection gas pressure of the pressure sensor PS 1 becoming below default value on the way, supply hydrogen gas pressure will progress to R8 by abnormalities (pressure regulator PR are abnormalities), and will stop a starting process there. In addition, I hear that repeating the above R1-R6 the number of convention times repeats the check of supply hydrogen gas pressure the number of convention times after all, and there is.
[0049] Drawing 8 is drawing showing other supply-gas-pressure check procedures. When the check procedure shown in above-mentioned drawing 7 repeated a gas-pressure check, it opened the bulb SV 3 and emitted hydrogen gas to atmospheric air, but only when unusual, before emitting hydrogen gas to atmospheric air, it is going to emit in a fuel cell system, and the procedure shown in this drawing 8 is emitted to atmospheric air, it tends to check repeatedly and, thereby, still tends to aim at reduction of atmospheric-air emission of hydrogen gas.
[0050] In this procedure, a bulb SV 1 is opened by S1, the detection gas pressure of the pressure sensor PS 1 judges whether it is below default value by S2, a bulb SV 2 is opened by S13 at the time of below default value, and a bulb SV 1 is closed by S3 from default value at the adult time. It is the same as the above-mentioned procedure so far. And after closing this bulb SV 1, in this procedure, a bulb SV 2 is opened by S4, hydrogen gas is emitted to a fuel cell 2 side by this, and it judges whether the detection gas pressure of the pressure sensor PS 1 became below default value by S5. After it progresses to S6 from S5 since the gas pressure immediately after opening a bulb SV 2 has not yet become below default value, and it opens a bulb SV 2 there, waiting and between them, if detection gas pressure becomes below default value, it will close a bulb SV 2 by S12, and it repeats the step of S1 - S4 only for convention time amount again. And when the detection pressure force becomes below default value in S2 while having repeated this step of S1 - S4, it progresses to S13. it is now when the step of S1 - S4 is repeated without detection gas pressure becoming below default value in S2 — even if it goes through the post-convention time amount which may stop having emitted hydrogen gas in the fuel cell 2, and opened the bulb SV 2 since the hydrogen gas circulating pump GP is not operating among those, a pressure stops becoming below default value When it does so, until it progresses to S7 from S6, it opens a bulb SV 3 there and the detection gas pressure of the pressure sensor PS 1 becomes below default value by S8 Waiting, It judges whether when becoming below default value, the bulb SV 3 was closed by S9, and the count of activation of the step of S1 - S9 became the count of a convention in S10. If it has not reached, close a bulb SV 2 by S12, and return to S1, and S1 - S9 are repeated again. If the count of a repeat of S1 - S9 becomes the count of a convention, without progressing to S13 and detection gas pressure becoming below default value by S2, if detection gas pressure becomes below default value in S2 by the middle, a starting process will be stopped by S11.
[0051] Next, the gas leak check shown in Q5 of drawing 6 is explained. As mentioned above, if judged as gas pressure normal by the supply-gas-pressure check, a bulb SV 2 and SV2' will be opened, and a gas leak check is performed. The above-mentioned flow rate sensor FS and FS' perform this gas leak check. When hydrogen gas and oxygen gas flow to some extent, the pressure of the hydrogen gas in a fuel cell 2 and oxygen gas approaches the pressure which rose and was adjusted by above-mentioned pressure regulator PR and PR', and ****** flow becomes namely, although hydrogen gas and oxygen gas flow towards the inside of a fuel cell 2 immediately after opening a bulb SV 2 and SV2', since the gas circulating pump GP and GP' are not yet operating at this time, is not henceforth less towards a fuel cell 2. However, when the gas leak by breakage etc. has arisen in the fuel cell 2 at this time, it turns to a fuel cell 2 succeedingly, and hydrogen gas and oxygen gas are specified quantity flow ******.
[0052] Then, flow rate sensor FS and FS' prepared between the above-mentioned bulb SV 2 and the fuel cell 2 detects a quantity of gas flow. When the detection flow rate after convention time amount progress is beyond default value, from the time of opening a bulb SV 2 and SV2' Those with a gas leak, It judges that he has no gas leak than default value at the time of smallness, and a starting process is stopped at the time with the gas leak of either hydrogen gas and oxygen gas, and when all have no gas leak, it shifts to the next short circuit check.

[0053] Next, the short circuit check shown in Q6 of drawing 6 is explained. It confirms whether a short circuit check leaks through cooling water, and this short circuit check detects the electric conductivity of cooling water by the above-mentioned conductivity sensor CS, when conductivity is beyond default value, starting is suspended by those with a possibility that it may be short-circuited through cooling water, and it moves to the next electrical-potential-difference check by having no fear of a short circuit than default value at the time of smallness.
[0054] Next, the electrical-potential-difference check shown in Q9 of drawing 6 is explained. As mentioned above, at the time of starting, the generation water by the reaction of the residual gas at the time of an actuation halt adheres to the proton exchange film, and the case where a normal reaction generation of electrical energy is barred may arise. Therefore, starting is suspended, when it confirms whether the fuel cell 2 has generated electricity normally and a normal generation of electrical energy is not performed at the time of starting. In addition, as a cause that this normal generation of electrical energy is not performed, besides water adhesion on the above-mentioned proton exchange film, failure of the various fuel cell itself, such as breakage of a fuel cell, and proton exchange film, electrode degradation, can be considered, the above-mentioned electrical-potential-difference check can detect not only the trouble by water adhesion but failure of such a fuel cell itself, and starting can be stopped according to it.
[0055] The procedure of this electrical-potential-difference check is explained referring to drawing 9 . First, the gas circulating pump GP and GP' are operated by T1 (Q8 reference of drawing 6). Next, an electrical-potential-difference check is performed by T2. the electrical potential difference of two or more generation-of-electrical-energy cel groups of each, to whom this electrical-potential-difference check changes from each generation-of-electrical-energy cel 2 or two or more generation-of-electrical-energy cels 8 of a fuel cell 2 by above-mentioned voltage sensor VS, — detecting -- any of those electrical potential differences — although — if one of electrical-potential-difference normal is smallness from default value with default value [beyond] (it comes out and determined based on the electrical potential difference which will become if it originally generates electricity to normal and which will exist), it will be judged as the abnormalities in an electrical potential difference. and -- if an electrical potential difference does not reach abnormalities and either does not reach even default value, until it carries out convention time amount progress by T3 — waiting (since there is a thing of an electrical potential difference done for a predetermined time important point for starting), and before carrying out convention time amount progress -- all electrical potential differences — beyond default value — becoming — an electrical potential difference — if it judges that it is normal, it will progress to T5, a starting process is ended, actuation of a fuel cell is continued as it is henceforth, and it usually shifts to actuation. Moreover, if one of electrical potential differences does not reach default value even if it carries out predetermined time progress, it judges that an electrical potential difference is unusual, and progresses to T four, and a starting process is stopped.
[0056] Drawing 10 is drawing showing other electrical-potential-difference check procedures. Since an above-mentioned procedure operates the gas circulating pump GP and GP', and it suspends starting when an electrical potential difference still does not reach default value, the waiting for convention time amount, and Although it becomes deactivation as it is when attached groundwater still remains, although attached groundwater was removed to some extent by the above-mentioned gas circulating pump GP and the gas stream by actuation of GP' If it considers as deactivation only when an electrical potential difference is unusual after being able to remove those attached groundwater fundamentally, therefore removing such attached groundwater While being able to decrease the deactivation by attached groundwater, only in the case of the abnormalities in an electrical potential difference by truly unremovable attached groundwater, it can consider as deactivation, and it is convenient.
[0057] Drawing 6 is drawing showing the electrical-potential-difference check procedure incorporating this attached groundwater removal. If it is judged before waiting and convention time amount progress that a generation-of-electrical-energy electrical potential difference is normal until it operates the gas circulating pump GP and GP' by U1 first, it performs the same electrical-potential-difference check as T2 by U2 and it carries out convention time amount progress by U3 like illustration, it will progress to U8 and a starting process will be ended. It is the same as T1 and T2 of the procedure shown in drawing 9 so far, T3, and T5.
[0058] Next, even if it carries out convention time amount progress, when a generation-of-electrical-energy electrical potential difference does not become normal, a waterdrop removal process (attached groundwater removal control) is performed by U4. Increase of a quantity of gas flow or the increase and decrease of change of a quantity of gas flow can perform this waterdrop removal process. Increase of a quantity of gas flow discharges the oxygen gas and hydrogen gas in a fuel cell 2 at a stretch by opening purge valve SV5' on oxygen gas and the hydrogen gas circuit 56, and 66, and SV5, and thereby, although it is at the moment at a target, it can be performed by the approach of increasing the flow rate of approach or oxygen gas circulating-pump GP' which increases a quantity of gas flow, and the hydrogen gas circulating pump GP. The increase and decrease of change of a quantity of gas flow can be performed repeating turning on and off of above-mentioned oxygen gas circulating-pump GP' and the hydrogen gas circulating pump GP, or by repeating closing motion of above-mentioned circuit closing motion bulb SV4' prepared on oxygen gas and the hydrogen gas circuit 56, and 66, and SV4.
[0059] If the same electrical-potential-difference check as T5 is performed by U5 and an electrical potential difference becomes normal, performing the above-mentioned waterdrop removal process, a waterdrop removal process is ended, it will progress to U8 and a starting process will be ended. Only when it is not judged by U5 that an electrical potential difference is normal and a generation-of-electrical-energy electrical potential difference does not become normal even if it judges whether the waterdrop removal process was performed the count of a convention, or convention time by U6 and the count of a convention or a convention time amount waterdrop removal process is performed, a starting process is stopped by U7.

[0060] In above-mentioned drawing 9 and the example shown in 10, although the generation-of-electrical-energy electrical potential difference of each generation-of-electrical-energy cel or the generation-of-electrical-energy electrical potential difference of each generation-of-electrical-energy cel group has judged the normal abnormalities of a generation-of-electrical-energy electrical potential difference by whether it is beyond default value Dispersion in the generation-of-electrical-energy electrical potential difference in each generation-of-electrical-energy cel (For example, difference of maximum and the minimum value) or dispersion in the generation-of-electrical-energy electrical potential difference between each generation-of-electrical-energy cel group (the generation-of-electrical-energy electrical potential difference of a generation-of-electrical-energy cel group is total of the generation-of-electrical-energy electrical potential difference of the generation-of-electrical-energy cel in the generation-of-electrical-energy cel group) by smallness (an electrical potential difference -- normal) from beyond default value (abnormalities in an electrical potential difference), and default value it can judge and beyond default value (an electrical potential difference -- normal) can also judge [the generation-of-electrical-energy electrical potential difference (total of the generation-of-electrical-energy electrical potential difference of each generation-of-electrical-energy cel in a fuel cell) of a fuel cell own / each] depending on whether it is smallness (abnormalities in an electrical potential difference) from default value.
[0061] In addition, although it is desirable for the cause of abnormalities of the generation-of-electrical-energy electrical potential difference to be unable to distinguish either in the procedure which not only attached groundwater but failure of a fuel cell is considered, and shows the cause of abnormalities of a generation-of-electrical-energy electrical potential difference in above-mentioned drawing 9 , to be able to remove fundamentally in the case of attached groundwater, and to remove, and to start as mentioned above, also when based on such attached groundwater, it considers as deactivation uniformly. However, according to the procedure shown in above-mentioned drawing 10, since ****** of the deactivation based on the abnormalities in an electrical potential difference by such attached groundwater can be avoided and can make it deactivation fundamentally only at the time of the abnormalities in an electrical potential difference by failure of the fuel cell immediately unsolvable on that spot itself, it is convenient.
[0062] Moreover, although the hydrogen gas and oxygen gas side is similarly constituted from an above-mentioned example about attached groundwater removal, attached groundwater removal control by actuation of the gas circulating pump by the above-mentioned dump power with the weight of the produced water generated especially in an oxyecoia room large [the problem of attached groundwater] therefore, or increase or increase and decrease of change of a quantity of gas flow can also be given only to an oxygen gas side.

[Translation done.]

* NOTICES *

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damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing showing one example of the fuel cell system in the fuel cell powered vehicle concerning this invention
[Drawing 2] Drawing showing the fuel cell in drawing 1
[Drawing 3] Drawing showing the flow of the hydrogen gas in the fuel cell in drawing 2 , oxygen gas, and cooling water
[Drawing 4] The sectional view showing the configuration of the generation-of-electrical-energy section of the fuel cell in drawing 2 , and the flow of oxygen gas
[Drawing 5] The flow chart which shows an example of the actuation shutdown procedure of a fuel cell system
[Drawing 6] The flow chart which shows an example of the activation procedure of a fuel cell system
[Drawing 7 , drawing 8] The flow chart which shows an example of a supply-gas-pressure check procedure, respectively
[Drawing 9 , drawing 10] The flow chart which shows an example of a generation-of-electrical-energy electrical-potential-difference check procedure, respectively
[Drawing 11 , drawing 12] Drawing showing the arrangement mode of the conventional fuel cell
[Description of Notations]
2 Fuel Cell
6 Generation-of-Electrical-Energy Section
8 Generation-of-Electrical-Energy Cel
20 Oxygen Gas Path
30 Hydrogen Gas Passageway
50 Oxygen Gas Source of Supply
56 Oxygen Gas Circuit
60 Source of Hydrogen Gas Supply
66 Hydrogen Gas Circuit
72 Drive Motor
GP Hydrogen gas circulating pump
GP' oxygen gas circuit pump
VS Voltage sensor

[Translation done.]

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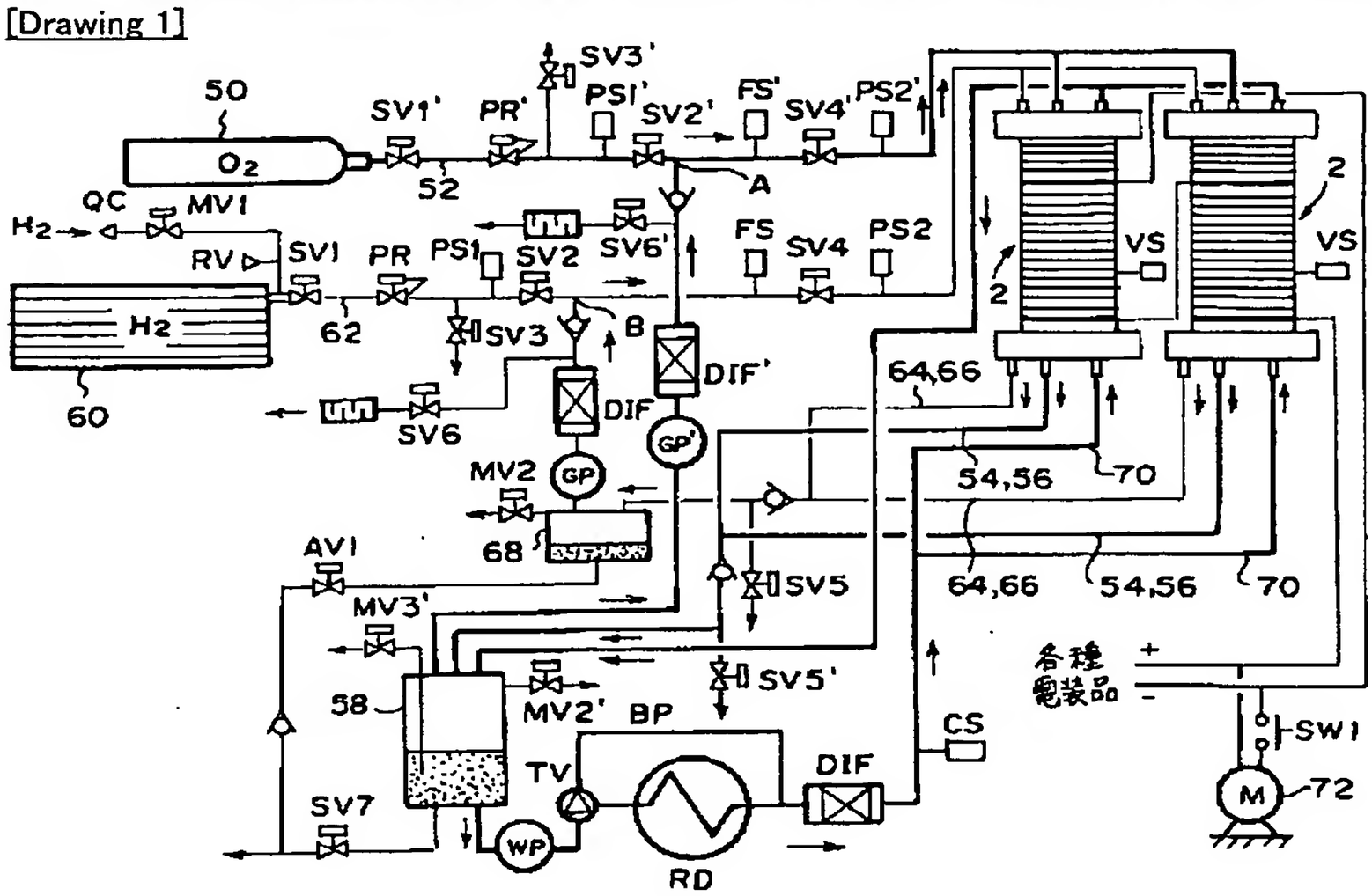
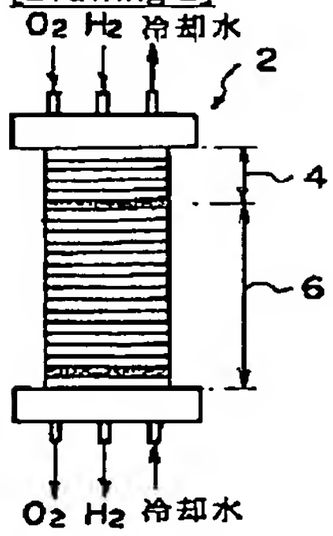
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



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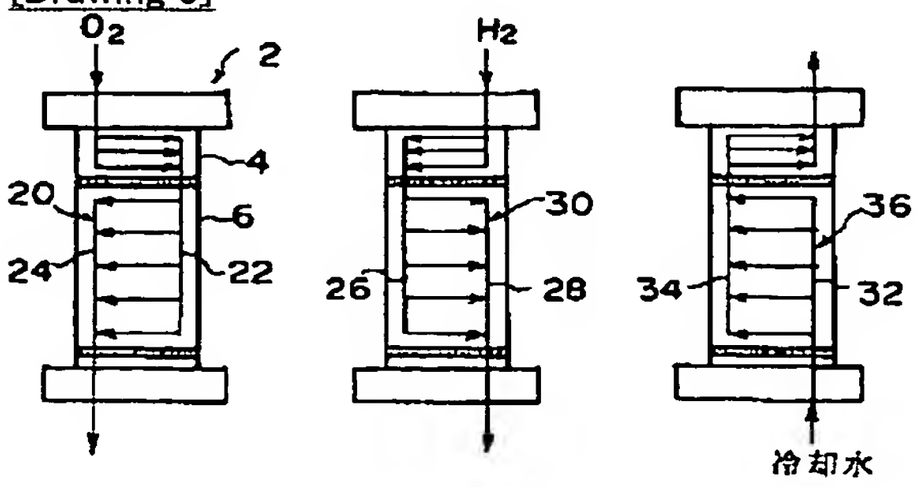

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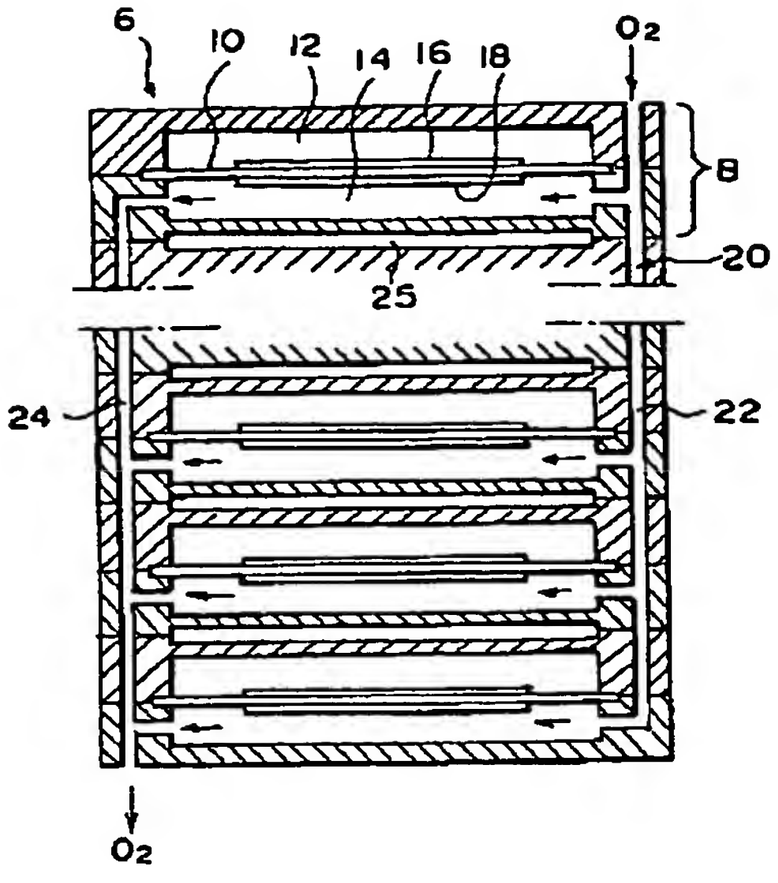
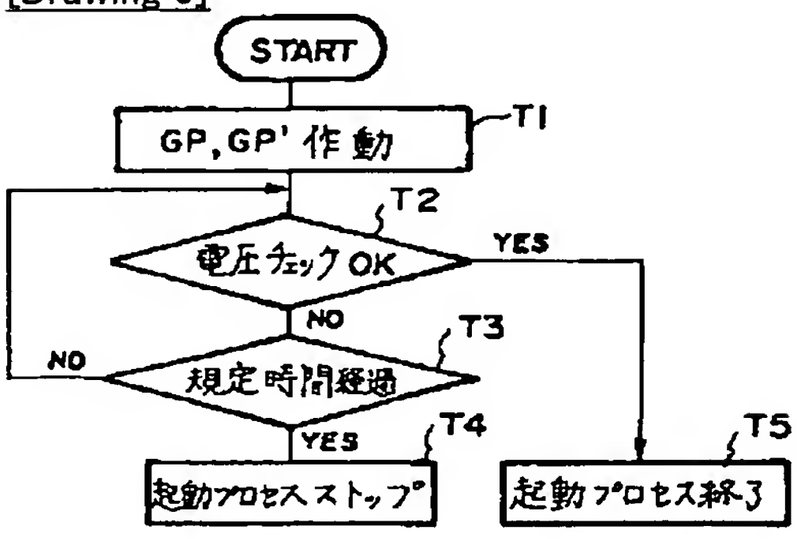


[Drawing 9]



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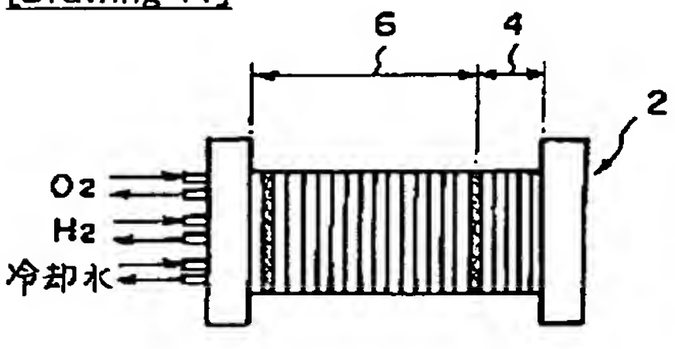
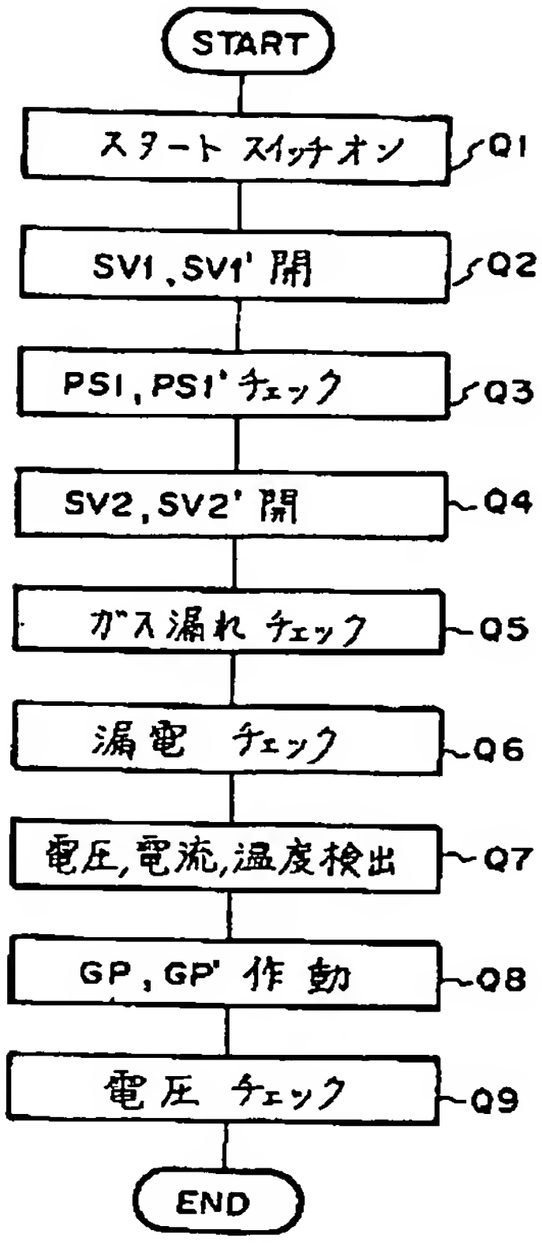
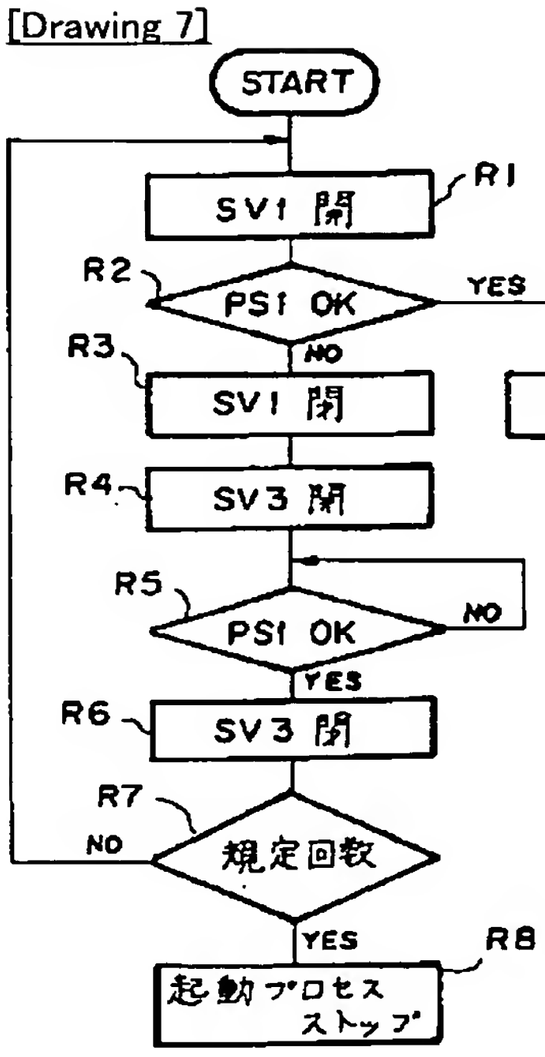


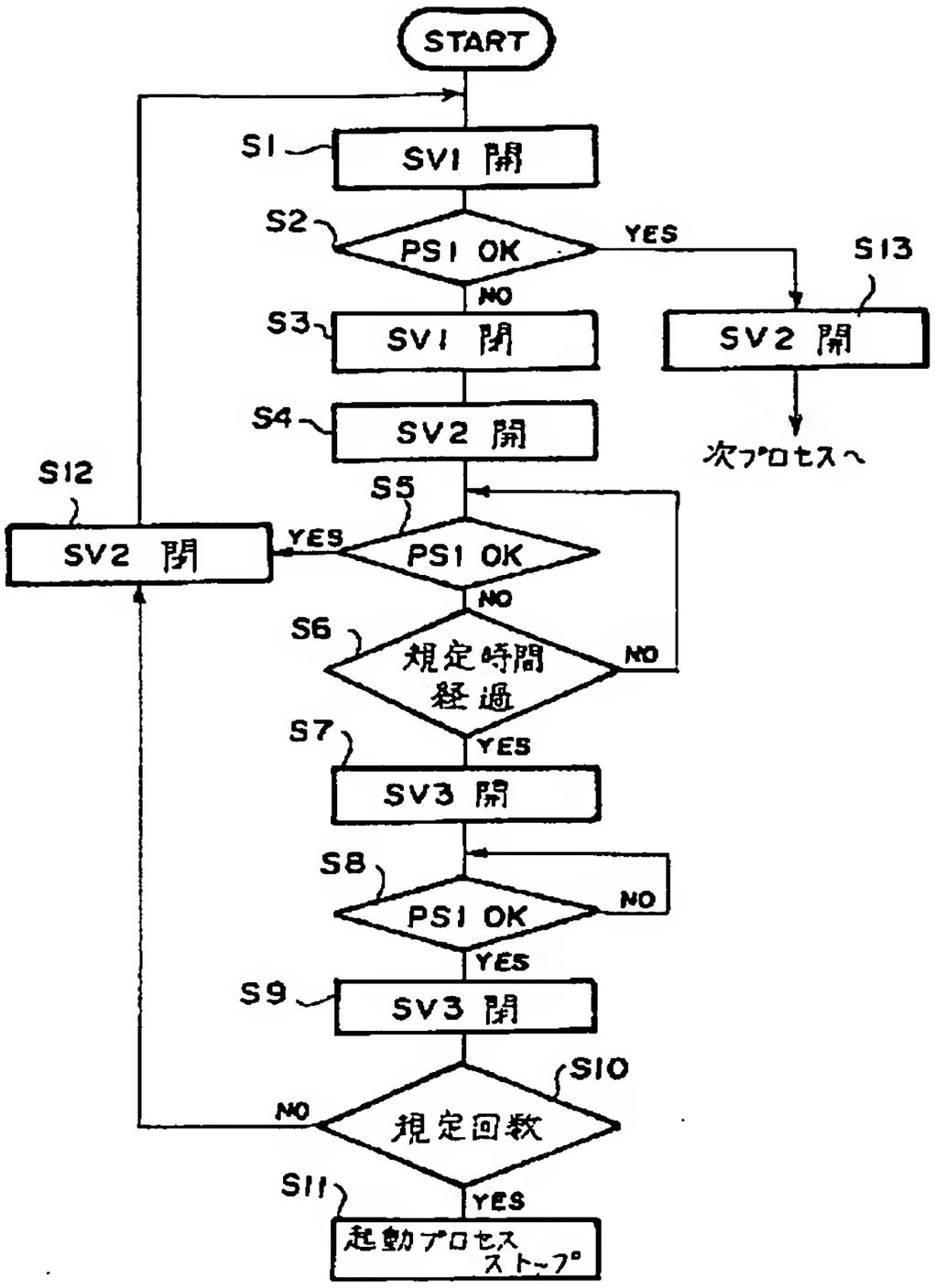
[Drawing 6]



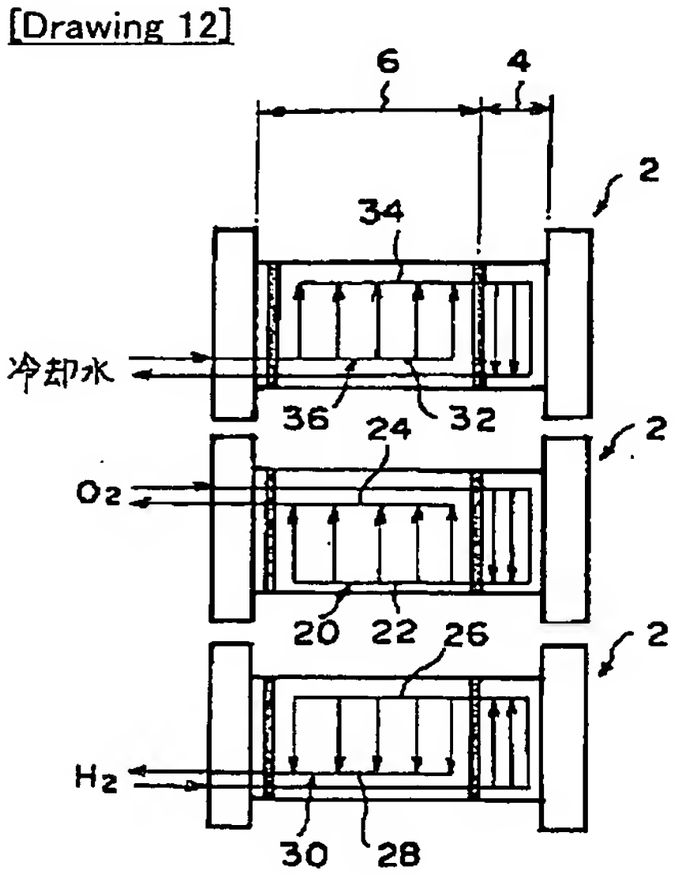
[Drawing 7]



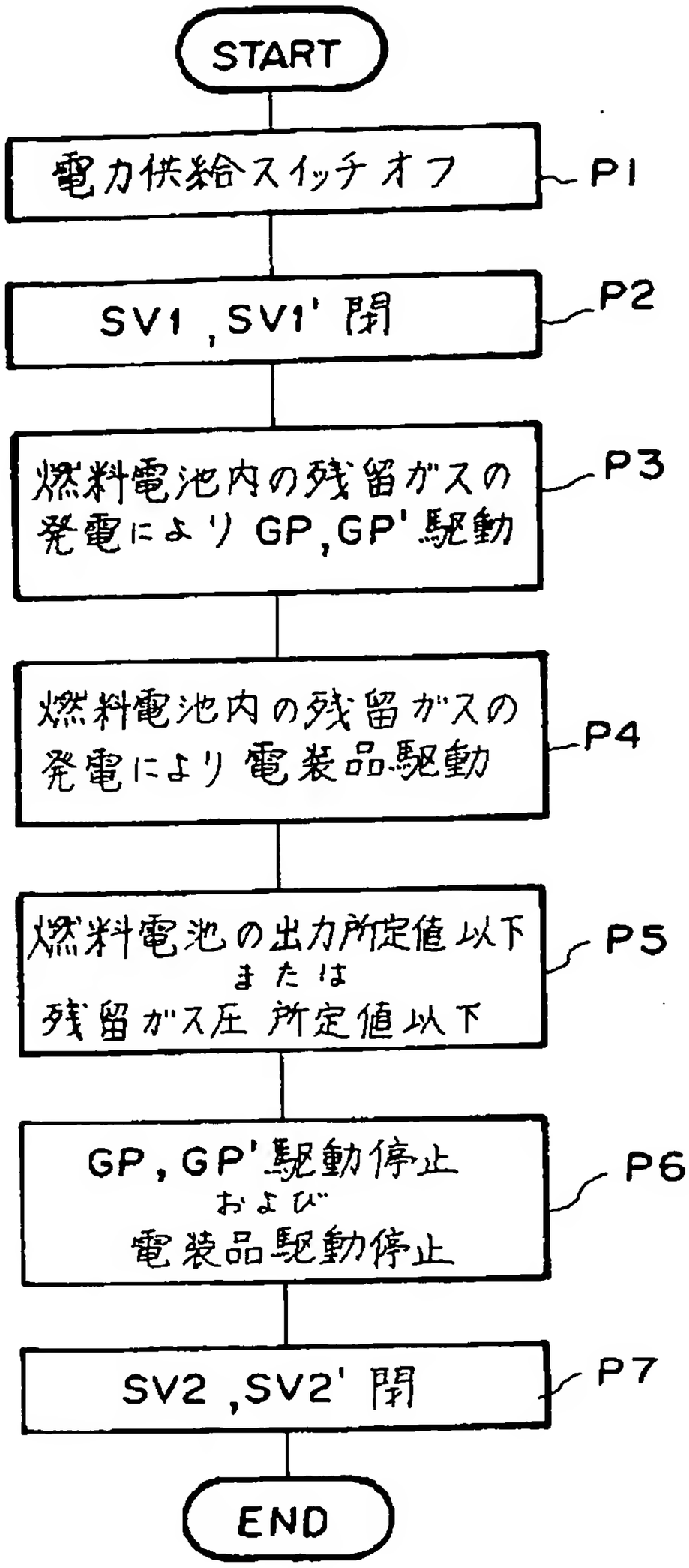
[Drawing 8]



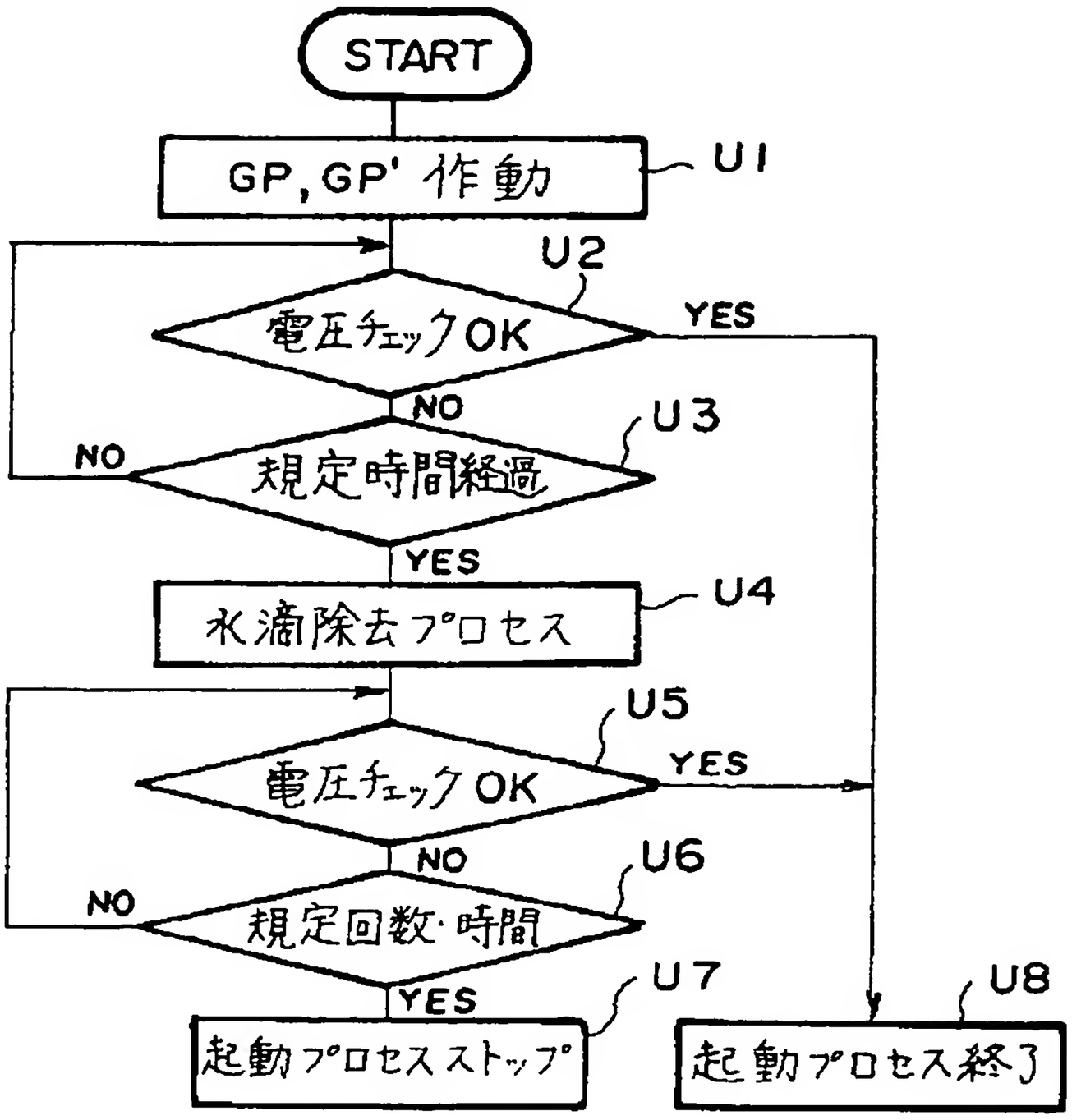
[Drawing 12]



[Drawing 5]


START
電力供給スイッチオフ
P1
SV1 ,SV1' 閉
P2
燃料電池内の残留ガスの
発電により GP,GP' 駆動
P3
燃料電池内の残留ガスの
発電により電装品駆動
P4
燃料電池の出力所定値以下
または
残留ガス圧 所定値以下
P5
GP,GP' 駆動停止
および
電装品駆動停止
P6
SV2 ,SV2' 閉
P7
END

[Drawing 10]



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最終頁に続く

(54)【発明の名称】　燃料電池自動車

(57)【特許請求の範囲】

【請求項１】　水素ガス供給源と酸素ガス供給源とから供給された水素ガスと酸素ガスとの反応により発電を行う燃料電池と、該燃料電池から排出された未反応の上記水素ガスおよび酸素ガスを再度上記燃料電池に供給する水素ガス循環路および酸素ガス循環路と、それぞれのガス循環路に設けられた水素ガス循環ポンプおよび酸素ガス循環ポンプとを備えて成り、上記燃料電池で発電した電気により走行用モータを駆動する燃料電池自動車であって、

上記燃料電池の作動停止時に、上記水素ガス供給源および酸素ガス供給源からの水素ガスおよび酸素ガスの供給を停止した後、上記燃料電池に残留している残留水素ガスと残留酸素ガスとの反応により発電した電気で、上記両ガス循環ポンプのうち少なくとも上記両ガスの反応による生成水の排出作用を有するガス側のガス循環ポンプを作動させるものであることを特徴とする燃料電池自動車。

【請求項２】　上記水素ガス供給源および酸素ガス供給源からの水素ガスおよび酸素ガスの供給を停止した後、上記燃料電池に残留している残留水素ガスと残留酸素ガスとの反応により発電した電気で、自動車に搭載した上記両ガス循環ポンプと共に該両ガス循環ポンプ以外の電装品をも作動させるものであることを特徴とする請求項１記載の燃料電池自動車。

【請求項３】　上記燃料電池の出力が規定値以下になったときまたは上記燃料電池内の水素ガス圧もしくは酸素ガス圧が規定値以下になったとき、上記両残留ガスの反応により発電した電気で作動せしめられているガス循環ポンプの作動を停止させるものであることを特徴とする

請求項１記載の燃料電池自動車。

【請求項４】　上記燃料電池の出力が規定値以下になったときまたは上記燃料電池内の水素ガス圧もしくは酸素ガス圧が規定値以下になったとき、上記両ガス循環ポンプ及び該両ガス循環ポンプ以外の電装品の作動を停止させるものであることを特徴とする請求項２記載の燃料電池自動車。

【請求項５】　上記両ガス循環ポンプ以外の電装品が、照明ランプ類、室内換気装置もしくは空気清浄器のうちの少なくとも一つから成ることを特徴とする請求項２または４記載の燃料電池自動車。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、水素ガスと酸素ガスとを反応させて発電する燃料電池を備え、該燃料電池で発電した電気により駆動される燃料電池自動車に関する。

【０００２】

【従来の技術】例えば米国特許第5,047,298号明細書には、水素と酸素とを反応させて発電を行なう燃料電池が開示されている。また、特開昭51–4717号公報には、その様な水素と酸素とを反応させて発電を行なう燃料電池を備え、該燃料電池で発電した電気により走行用モータを駆動して走行する燃料電池自動車が開示されている。

【０００３】上記の如き燃料電池としては、例えばプロトン交換膜を用いたＰＥＭ型燃料電池が知られている。かかる燃料電池は、プロトン交換膜を挟んで酸素室と水素室とが設けられ、両室に加湿酸素ガスと加湿水素ガスとを供給し、水素室でイオン化された水素イオンがプロトン交換膜を通って酸素室に入り、この酸素室で水素と酸素とを反応させて発電を行なうものである。

【０００４】この様な燃料電池は、従来図11，図12に示す様に横置きにして自動車に配設されている。即ち、燃料電池２は、酸素ガスと水素ガスを加湿する加湿部４と、上記プロトン交換膜と酸素室と水素室とを備えた発電セルを複数個積み重ねた発電部６とを備えて成り、各発電セルの酸素室に酸素ガスを供給し排出する酸素ガス通路20（供給側通路22および排出側通路24）、各発電セルの水素室に水素ガスを供給し排出する水素ガス通路30（供給側通路26および排出側通路28）および各発電セルを冷却する冷却水を供給し排出する冷却水通路36（供給側通路32および排出側通路34）がそれぞれ上記各発電セルの積み重ね方向（図中左右方向）に延びて配設され、かかる燃料電池２をその各セルの積み重ね方向が水平方向（図中左右方向）になるように横置きにして自動車に配設され、従って酸素ガス通路20、水素ガス通路30および冷却水通路36はいずれも水平方向に延びる態様となっている。

【０００５】

【発明が解決しようとする課題】ところで、上記の如き燃料電池は、水素と酸素とを反応させるのでその反応により水が生成され、従って例えば上記の如きプロトン交換膜を用いたＰＥＭ型燃料電池の場合、その生成水がプロトン交換膜に付着し、発電に支障が生じることがある。また、その様なプロトン交換膜を用いたＰＥＭ型燃料電池の場合、水素ガスと酸素ガスとを反応させるためその水素ガスと酸素ガスとに水分を含有させる必要があり、その水素ガスおよび酸素ガスに含有されている水分が上記プロトン交換膜に付着し、発電に支障が生じることがある。

【０００６】さらに、燃料電池作動時には、燃料電池内を水素ガスと酸素ガスが流動しているので、上記反応による生成水や上記水素ガスや酸素ガスに含有されている水分はその水素ガスや酸素ガスの流れによって該流れと共に上記水素ガス通路および酸素ガス通路を通って燃料電池外部にある程度排出されるが、燃料電池の作動停止時には、もはや上記水素ガスや酸素ガスの流れは停止され、その流れが停止した状態の下で燃料電池内の残留水素ガスと残留酸素ガスとがしばらくの間反応し続け、従ってその残留水素ガスと残留酸素ガスとの反応により生成した水もしくはそれらの残留ガスに含有されている水分は、上記燃料電池の作動時の様に水素ガスと酸素ガスの流れによって外部に排出することはできず、それらはプロトン交換膜に付着し、従ってその後の起動時にこの付着水により発電に支障を来たすことがある。

【０００７】上記プロトン交換膜への付着水の問題は、特に反応生成水によるものが顕著であり、上記ＰＥＭ型燃料電池の場合上述の様に酸素室で反応して水が生成されるので、上記付着水の問題を解決するにあたっては、特にこの酸素室側において生成される水の付着を解決することが重要である。

【０００８】本発明の目的は、上記事情に鑑み、水素ガスと酸素ガスとの反応による生成水に起因するトラブルを防止することのできる燃料電池自動車を提供することにある。

【０００９】

【課題を解決するための手段】本発明に係る燃料電池自動車は、上記目的を達成するため、水素ガス供給源と酸素ガス供給源とから供給された水素ガスと酸素ガスとの反応により発電を行う燃料電池と、該燃料電池から排出された未反応の上記水素ガスおよび酸素ガスを再度上記燃料電池に供給する水素ガス循環路および酸素ガス循環路と、それぞれのガス循環路に設けられた水素ガス循環ポンプおよび酸素ガス循環ポンプとを備えて成り、上記燃料電池で発電した電気により走行用モータを駆動する燃料電池自動車であって、上記燃料電池の作動停止時に、上記水素ガス供給源および酸素ガス供給源からの水素ガスおよび酸素ガスの供給を停止した後、上記燃料電池に残留している残留水素ガスと残留酸素ガスとの反応により発電した電気で、上記両ガス循環ポンプのうち少なくとも上記両ガスの反応による生成水の排出作用を有

するガス側のガス循環ポンプを作動させるものであることを特徴とする。

【００１０】本発明に係る燃料電池自動車においては、上記水素ガス供給源および酸素ガス供給源からの水素ガスおよび酸素ガスの供給を停止した後、上記燃料電池に残留している残留水素ガスと残留酸素ガスとの反応により発電した電気で、自動車に搭載した上記両ガス循環ポンプと共に該両ガス循環ポンプ以外の電装品をも作動させるものとして構成することができる。

【００１１】また、上記燃料電池の出力が規定値以下になったときまたは上記燃料電池内の水素ガス圧もしくは酸素ガス圧が規定値以下になったとき、上記両残留ガスの反応により発電した電気で作動せしめられているガス循環ポンプの作動を停止させるものとして構成することができる。

【００１２】また、上記燃料電池の出力が規定値以下になったときまたは上記燃料電池内の水素ガス圧もしくは酸素ガス圧が規定値以下になったとき、上記両ガス循環ポンプ及び該両ガス循環ポンプ以外の電装品の作動を停止させるものとして構成することができる。

【００１３】また、上記両ガス循環ポンプ以外の電装品としては、照明ランプ類、室内換気装置もしくは空気清浄器を挙げることができる。

【００１４】

【作用および発明の効果】本発明に係る燃料電池自動車は、上述の様に、燃料電池の作動停止時に、残留水素ガスと残留酸素ガスとの反応により発電された電気で両ガス循環ポンプのうち少なくとも上記両ガスの反応による生成水の排出作用を有するガス側のガス循環ポンプ（上記ＰＥＭ型燃料電池の場合は酸素ガス循環ポンプ）を作動させるので、反応生成水排出作用を有する残留ガスの流れが形成され、従って残留ガス反応による生成水をこの残留ガスの流れにより燃料電池内から排出させることができ、燃料電池内での残留ガス反応生成水の付着によるトラブル、例えばＰＥＭ型燃料電池の場合その反応生成水のプロトン交換膜への付着によるトラブル発生を抑制することができ、特に燃料電池の再始動時における残留ガス反応生成水の付着によるトラブル発生を防止することができる。

【００１５】また、上記残留ガス反応による電気により両ガス循環ポンプのみならずそれら以外の電装品をも作動させることにより、この残留ガス反応による余剰電気の有効利用を図ることができる。

【００１６】また、燃料電池の出力もしくは燃料電池内のガス圧が規定値以下となった時点で上記ガス循環ポンプや電装品の作動を停止させることにより、それらの作動停止を適切に行なうことができる。

【００１７】また、上記電装品として、照明ランプ類、室内換気装置もしくは空気清浄器という自動車の停止中に作動させることが必要もしくは有効なものを選択することにより、上記余剰電力の利用をより一層有効なものとすることができる。

【００１８】

【実施例】以下、図面を参照しながら本発明の実施例について詳細に説明する。

【００１９】＜燃料電池システムの基本構成＞

図１は本発明に係る燃料電池自動車の一実施例における燃料電池システムの基本構成を示す図、図２は図１中の燃料電池を示す図、図３は図２に示す燃料電池における反応ガスである水素ガスと酸素ガスおよび冷却水の流れを示す図、図４は図２に示す燃料電池における酸素ガスの流れを示す詳細断面図である。

【００２０】まず、図２，３および４を参照しながら燃料電池について説明する。本実施例では燃料電池としてプロトン交換膜を使用した水素ガスと酸素ガスとを反応させて発電するＰＥＭ型燃料電池を用いている。

【００２１】図２に示す様に、この燃料電池２は、加湿部４と発電部６とを備え、加湿部４で純水を用いた冷却水により反応ガスである酸素ガスと水素ガスとを加湿し、発電部６でこれらの加湿された酸素ガスと水素ガスとを反応させて発電し、かつこの反応により反応熱が生じる発電部６を上記冷却水で冷却する様に構成されている。

【００２２】上記加湿部４は複数の加湿セルを積み重ねて成り、酸素ガス、水素ガスおよび冷却水は各セルを順次通り、各セルで加湿される。各セルでの加湿は水分を通過させる高分子膜を介して酸素ガスおよび水素ガスを冷却水と接触させて酸素ガスおよび水素ガスに飽和蒸気圧の水分を含有させることにより行なわれる。

【００２３】上記発電部６は、図４に示す様に、複数の発電セル８を積み重ねて成り、上記加湿部４で加湿された酸素ガスと水素ガスとが各セル８を順次通り、各セル８で反応して発電する。各セル８は、水素イオンのみを通すプロトン交換膜10と、該プロトン交換膜10によって区画された水素室12および酸素室14と、上記プロトン交換膜10に設けられた水素側電極16および酸素側電極18を備えて成る。

【００２４】発電部６には各発電セル８の積み重ね方向に延びる酸素ガス通路20が設けられている。この酸素ガス通路20は、各セル８の積み重ね方向に延びる供給側通路22と排出側通路24とを備え、供給側通路22から各セル８の酸素室14に酸素ガスを供給し、各セル８の酸素室14から未反応酸素ガスを排出側通路24を介して排出する。また、発電部６には、この酸素ガス通路20と同様に構成された図示しない水素ガス通路が設けられている。この水素ガス通路も、上記酸素ガス通路20と同様に、各セル８の積み重ね方向に延びる供給側通路と排出側通路とを備え、供給側通路から各セルの水素室12に水素ガスを供給すると共に各セルの水素室12から未反応水素ガスを排出側通路を介して排出する。さらに、発電部６には、図

示しない冷却水通路が設けられており、この冷却水通路も上記酸素ガス通路20と同様に各セル８の積み重ね方向に延びる供給側通路と排出側通路とを備え、供給側通路から各セル８間に形成された冷却水室25に冷却水を供給すると共に各冷却水室25から冷却水を排出側通路を介して排出する。

【００２５】上記各発電セル８における発電メカニズムは次の通りである。即ち、各セル８の水素室12に供給された加湿水素は水素側電極16の下でイオン化され、この水素イオンがプロトン交換膜を通って酸素室14に入り該酸素室14において酸素側電極18の下で水素と酸素とが反応し、該反応により発電をすると共に水が生成され、この生成水は未反応酸素ガスと共に酸素の排出側順路24から未反応酸素ガスの流れによって排出される。

【００２６】図３に上記加湿部４および発電部６における酸素ガス、水素ガスおよび冷却水の通路および流れを示す。図示の様に、供給側通路26および排出側通路28を備えて成る水素ガス通路30も、供給側通路32および排出側通路34を備えて成る冷却水通路36も上記酸素ガス通路20と同様に各セル８の積み重ね方向に延びている。また、燃料電池２は各セル８の積み重ね方向を上下方向として配設され、加湿部４は発電部６の上部に位置し、酸素ガス通路20、水素ガス通路30および冷却水通路36はいずれも上下方向に延び、酸素ガスおよび水素ガスは上から供給して下に排出するように、冷却水は下から供給して上に排出する様に構成されている。

【００２７】上記の様に、燃料電池２をその発電部６を通る水素ガス通路30および酸素ガス通路20の延びる方向が上下方向になるように縦置き配設し、上記水素ガス通路30および酸素ガス通路20にはそれぞれの上部から水素ガスおよび酸素ガスを供給し、下部から未反応の水素ガスおよび酸素ガスを排出する様に構成することにより、上記水素ガスおよび酸素ガスはその上下方向に延びる水素ガス通路30および酸素ガス通路20内を下方に向かって流れることとなる。従って、水素ガスおよび酸素ガスの流れによって排出される水分に対して重力がその排出方向に働き、この重力によって水分の排出が助長され、反応生成水や水素ガスおよび酸素ガスに含まれていた水分の排出性の向上が図られ、燃料電池内での水付着によるトラブル、例えばＰＥＭ型燃料電池の場合のプロトン交換膜への水付着によるトラブルの発生を抑制することができる。

【００２８】次に、図１を参照しながら上述の燃料電池を用いた自動車における燃料電池システムについて説明する。図示の燃料電池システムは、２個の燃料電池２を備え、両燃料電池２には酸素ガス、水素ガスおよび冷却水が並列的に供給され、各燃料電池２で発電した電気は直列的に取り出される。

【００２９】各燃料電池２には、酸素ガス供給源である高圧酸素ボンベ50から酸素ガス供給路52を介して酸素ガスそのものが供給される。また、各燃料電池２からは未反応酸素ガスが酸素ガス排出路54を介して排出され、該酸素ガス排出路54はＡ点において上記酸素ガス供給路52に接続され、各燃料電池２内の酸素ガス通路と上記酸素ガス排出路54と上記酸素ガス供給路52のうち上記Ａ点から燃料電池２までの部分とで酸素ガス循環路56が形成され、上記未反応酸素ガスはこの酸素ガス循環路56を通って循環せしめられる。

【００３０】上記酸素ガス供給路52には、酸素ガス供給源50側から順に元バルブであるソレノイドバルブＳＶ１′、供給酸素ガス圧を一定に保つ圧力レギュレータＰＲ′、分岐路に設けられたソレノイドバルブＳＶ３′、圧力センサＰＳ１′、入口バルブであるソレノイドバルブＳＶ２′が設けられ、かつ酸素ガス循環路56兼用部分には流量センサＦＳ′、循環路開閉バルブであるソレノイドバルブＳＶ４′、圧力センサＰＳ２′が設けられている。上記酸素ガス排出路54には、分岐路に設けられたパージバルブであるソレノイドバルブＳＶ５′、水トラップ容器（水セパレータ）58、酸素ガス循環ポンプＧＰ′および脱イオンフィルタＤＩＦ′が設けられている。

【００３１】また、各燃料電池２には、水素ガス供給源である水素を吸蔵した水素吸蔵合金60から水素ガス供給路62を介して水素ガスそのものが供給される。また、各燃料電池２からは未反応水素ガスが水素ガス排出路64を介して排出され、該水素ガス排出路64はＢ点において上記水素ガス供給路62に接続され、各燃料電池２内の水素ガス通路と上記水素ガス排出路64と上記水素ガス供給路62のうち上記Ｂ点から燃料電池２までの部分とで水素ガス循環路66が形成され、上記未反応水素ガスはこの水素ガス循環路66を通って循環せしめられる。

【００３２】上記水素ガス供給路62には、水素ガス供給源60側から順に元バルブであるソレノイドバルブＳＶ１、供給水素ガス圧を一定に保つ圧力レギュレータＰＲ、分岐路に設けられたソレノイドバルブＳＶ３、圧力センサＰＳ１、入口バルブであるソレノイドバルブＳＶ２が設けられ、かつ水素ガス循環路66兼用部分には流量センサＦＳ、循環路開閉バルブであるソレノイドバルブＳＶ４、圧力センサＰＳ２が設けられている。上記水素ガス排出路64には、分岐路に設けられたパージバルブであるソレノイドバルブＳＶ５、水トラップ容器（水セパレータ）68、水素ガス循環ポンプＧＰおよび脱イオンフィルタＤＩＦが設けられている。また、上記水素ガス供給源60とソレノイドバルブＳＶ１との間には分岐路が設けられ、リークバルブＲＶ、マニュアルバルブＭＶ１およびクイックコネクタＱＣが設けられ、水素吸蔵合金60に水素を吸蔵させる際、水素ボンベ（図示せず）がこのクイックコネクタＱＣに接続される。

【００３３】また、各燃料電池２には冷却水循環路70が設けられている。該冷却水循環路70は燃料電池２内の図

示しない前述の冷却水通路を含んで成り、該冷却水循環路70には上述の水トラップ容器58、冷却水循環ポンプＷＰ、三方弁ＴＶ、冷却水放熱用のラジエタＲＤ、該ラジエタＲＤと並列的に設けられたバイパスＢＰおよび脱イオンフィルタＤＩＦ、冷却水の導電率を検出する導電率センサＣＳが設けられている。

【００３４】また、上記各燃料電池２には、発電部６の各発電セル８の出力電圧を検出する電圧センサＶＳが設けられ、また両燃料電池２を直列に接続した電線には電力供給スイッチＳＷ１を介して走行用モータ72が接続されると共に図示しない電力供給スイッチを介して各種の電装品（上述のガス循環ポンプＧＰ，ＧＰ′も含む）が接続されている。

【００３５】また、上記システムにおいては、その他にも図示の如きソレノイドバルブＳＶ６，ＳＶ６′，ＳＶ７，マニュアルバルブＭＶ２，ＭＶ２′，ＭＶ３′およびオートバルブＡＶ１が設けられている。

【００３６】上記の如く構成されたシステムにおいては、通常の燃料電池作動停止時には、ソレノイドバルブＳＶ４，ＳＶ４′を除きその他のすべてのソレノイドバルブ、マニュアルバルブ、オートバルブおよびリークバルブは閉成され、各循環ポンプＧＰ，ＧＰ′ＷＰは駆動停止され、かつ走行用モータ72のスイッチＳＷ１および各種電装品のスイッチは開成されている。

【００３７】また、通常の燃料電池作動時（運転時）には、ソレノイドバルブＳＶ１，ＳＶ２，ＳＶ１′，ＳＶ２′を開成し、水素ガスおよび酸素ガス循環ポンプＧＰ，ＧＰ′を作動させ、各燃料電池２に酸素ガスおよび水素ガスを供給すると共にそれらを循環させ（酸素ガスおよび水素ガス供給源50，60からは反応により消費した量だけ新たに酸素ガスおよび水素ガスが供給される）、また冷却水循環ポンプＷＰを作動させて冷却水を燃料電池２に循環させ、もって前述のメカニズムにより各燃料電池２での発電および各燃料電池２の冷却が行なわれ、さらにスイッチＳＷ１を閉成してその発電した電気により走行用モータ72を駆動すると共に上述の図示しないスイッチを閉成して各種電装品に電力を供給する。

【００３８】＜燃料電池システムの作動停止手順＞

次に、上記燃料電池システムの作動停止手順について図５を参照しながら説明する。この作動停止は、燃料電池２内の残留ガスの反応による生成水を良好に排除し、かつその残留ガスの反応による余剰電力の有効利用を図り得る手順で行なわれる。

【００３９】まず、Ｐ１で燃料電池から外部負荷への電力供給スイッチつまり走行用モータ72への電力供給スイッチＳＷ１および上述の各種電装品への電力供給スイッチ等をオフにし、その後Ｐ２でバルブＳＶ１，ＳＶ１′を閉じて水素ガス供給源60および酸素ガス供給源50から燃料電池２への水素ガスおよび酸素ガスの供給を停止する。

【００４０】しかしながら、この様に水素ガスおよび酸素ガスの供給を停止しても、燃料電池２内には水素ガスおよび酸素ガスが残っており、それらの残留ガスがその後も燃料電池２内で反応し続けるため、それによって発生した水がプロトン交換膜10に付着し、再起動時に反応ガスのプロトン交換膜への到達が妨げられることとなる。

【００４１】そこで、上記バルブＳＶ１、ＳＶ１′を閉じた後は、Ｐ３において、上記燃料電池２内の残留ガスの反応によって発電された電力を利用して水素ガス循環ポンプＧＰおよび酸素ガス循環ポンプＧＰ′を作動させる。この作動は両ガス循環ポンプＧＰ，ＧＰ′への電力供給スイッチを閉成しておくことにより行なう。これにより、残留ガスの反応中も水素ガス循環路66および酸素ガス循環路56内を水素ガスおよび酸素ガスが循環し、従ってその残留ガス中の水分および残留ガスの反応により生成された水はこの水素ガスおよび酸素ガスの流れによって良好に外部に排出され、燃料電池作動停止後のプロトン交換膜への水付着を防止することができる。

【００４２】また、Ｐ４において、上記ガス循環ポンプＧＰ，ＧＰ′の作動と共に残留ガスの反応により発電された余剰電力を利用してそれらのガス循環ポンプＧＰ，ＧＰ′以外の所定の電装品を作動させる。この作動は上記所定の電装品への電力供給スイッチを閉成することにより行なわれる。この電装品作動にあたっては、自動車の停車中に動作させることが必要または有効な電装品を作動させることが望ましく、その様は電装品としては、例えば足元ランプやハザードランプ等の照明ランプ類、車室内換気装置あるいは空気清浄器等を好適に作動させることができる。なお、上記車室内換気装置の作動にあたっては、例えば夏季の車室内温度上昇防止を目的として、車室内温度が外気温より高くかつ車室内温度が設定温度より高い場合に作動させることができる。

【００４３】続いて、Ｐ５で燃料電池２の出力電力もしくは残留ガス圧が所定値以下になったことを検出したら、残留反応ガスの量が十分減少したものとみなしてＰ６で上記ガス循環ポンプＧＰ，ＧＰ′の駆動を停止すると共に上記電装品の駆動を停止し、Ｐ７でバルブＳＶ２，ＳＶ２′を閉じて燃料電池システムを停止させる。上記燃料電池２の出力電圧は燃料電池２単位の電圧（１つの燃料電池を構成する複数の発電セルの発電電圧の総和）であっても良いし、各発電セル単位の電圧であっても良い。それらの電圧は上述の燃料電池２に設けられた電圧センサＶＳによって検出される。また、上記残留ガス圧は残留水素ガス圧でも残留酸素ガス圧でももしくはそれらの双方の残留ガス圧のいずれでも良く、それらの残留ガス圧は上述の圧力センサＰＳ２，ＰＳ２′によって検出することができる。

【００４４】上記の様に、燃料電池の作動停止後即ち燃料電池への反応ガスの供給停止後、残留ガスの反応によ

り発電された電気を用いて両ガス循環ポンプＧＰ，ＧＰ′を駆動するように構成したので、残留ガスの反応により生成された水および残留ガス含有水分をその残留ガスの流れにより良好に燃料電池２から排出することができ、かかる残留ガス反応生成水等による起動時のトラブルを防止することができる。

【００４５】また、その残留ガス反応により発電された余剰電力により、従来はその余剰電力をリークさせていたのに対し、上記の様に自動車停車中に動作させることが必要または有効な電装品を駆動するように構成したので、その余剰電力の有効利用を図ることができる。

【００４６】＜燃料電池システムの起動手順＞

次に、上記燃料電池システムの起動手順について、図６～図９を参照しながら説明する。上記燃料電池システムを起動する際には、上記燃料電池における付着水のチェックの他、供給ガス圧チェック、ガス洩れチェック、漏電チェックをそれぞれ自動的に行ない、全て問題がなければ燃料電池システムの通常作動に移行し、いずれかに不都合があれば起動を停止する。これにより、専門知識を有しない通常のユーザには困難な上記各チェックを自動的に行ない、不都合が存在するときは起動が自動的に停止されるので、安全走行の実現が図られる。

【００４７】図６に示す様に、上記燃料電池システムの起動にあたっては、まずＱ１で図示しない通常のバッテリから燃料電池システム制御回路へ電力を供給するスタートスイッチ（図示せず）（両ガス循環ポンプＧＰ，ＧＰ′への電力供給スイッチは除く）をオンさせる。続いてＱ２でバルブＳＶ１，ＳＶ１′を開にし、圧力センサＰＳ１，ＰＳ１′で供給ガス圧のチェックを行なう。供給ガス圧が異常のときは起動を停止し、正常のときはＱ４でバルブＳＶ２，ＳＶ２′を開にして酸素ガスおよび水素ガスを燃料電池２に供給する。そしてＱ５で燃料電池２におけるガス洩れをチェックし、ガス洩れがあれば起動を停止し、なければＱ６で漏電チェックを行ない、漏電があれば起動を停止し、なければＱ７で発電電圧、電流、温度を検出し、Ｑ８でガス循環ポンプＧＰ，ＧＰ′への電力供給スイッチを閉成して両ガス循環ポンプＧＰ，ＧＰ′を作動させ、Ｑ９で発電電圧をチェックし、電圧異常であれば起動を停止し、なければ起動時のチェックは全て正常ということでそのまま作動を続行して走行用モータ72への電力供給スイッチＳＷ１をオンさせる通常作動に移行する。

【００４８】次に、上記各チェックについて詳細に説明する。まず、供給ガス圧チェックは、図７に示す手順で行なう。図７は供給水素ガス圧のチェック手順であり、供給酸素ガス圧チェックもこれと同様に行なわれる。まず、Ｒ１でバルブＳＶ１を開く。このときバルブＳＶ２は未だ閉じており、従ってバルブＳＶ２までは水素ガス供給源50から水素ガスが供給され、かつ圧力レギュレータＰＲより下流側はその圧力レギュレータＰＲで所定のガス圧に調整されている。よって、この状態で圧力レギュレータＰＲとバルブＳＶ２との間に設けられた圧力センサＰＳ１で圧力を検出することにより供給ガス圧チェック（このガス圧チェックは結局圧力レギュレータＰＲのチェックである）を行ない、Ｒ２で検出ガス圧が規定値（圧力レギュレータＰＲにより調整されるべきガス圧に基づいて定められる）以下のときは供給ガス圧が正常ということでＲ９に進み、バルブＳＶ２を開き、次のプロセス（図６のＱ５）に進む。検出ガス圧が規定値より大でガス圧異常のときはＲ３に進み、そこで上記バルブＳＶ１を閉じてＲ４でバルブＳＶ３を開いて水素ガスを大気中に放出し、Ｒ５において圧力センサＰＳ１でガス圧を検出し、検出ガス圧が規定値以下まで下ったか否かを判断し、規定値以下に下がるまでＳＶ３を開き続け、規定値以下になったらＲ６でＳＶ３を閉じ、Ｒ７で上記Ｒ１～Ｒ６までの実行回数が規定回数に達したか否かを判断し、達していなければＲ１に戻り、再度Ｒ１～Ｒ６までのステップを実行する。そして、このＲ１～Ｒ６までのステップを繰り返し、その途中でＲ２において圧力センサＰＳ１の検出ガス圧が規定値以下となったらＲ９に進み、途中で圧力センサＰＳ１の検出ガス圧が規定値以下になることなくＲ１～Ｒ６までのステップの実行回数が規定回数に達したら、供給水素ガス圧が異常（圧力レギュレータＰＲが異常）ということでＲ８に進みそこで起動プロセスを停止する。なお、上記Ｒ１～Ｒ６を規定回数繰り返すということは、結局供給水素ガス圧のチェックを規定回数繰り返すということである。

【００４９】図８は他の供給ガス圧チェック手順を示す図である。上記図７に示すチェック手順はガス圧チェックを繰り返す際にバルブＳＶ３を開けて水素ガスを大気に放出するものであったが、この図８に示す手順は水素ガスを大気に放出する前に燃料電池システム内に放出し、それでも異常であった場合のみ大気に放出して繰り返しチェックを行なうものであり、これにより水素ガスの大気放出の減少を図ろうとするものである。

【００５０】この手順においては、Ｓ１でバルブＳＶ１を開き、Ｓ２で圧力センサＰＳ１の検出ガス圧が規定値以下か否かを判断し、規定値以下のときはＳ13でバルブＳＶ２を開き、規定値より大のときはＳ３でバルブＳＶ１を閉じる。ここまでは前述の手順と同じである。そして、このバルブＳＶ１を閉じた後、本手順ではＳ４でバルブＳＶ２を開き、これによって水素ガスを燃料電池２側に放出し、Ｓ５で圧力センサＰＳ１の検出ガス圧が規定値以下になったか否かを判断する。バルブＳＶ２を開けた直後のガス圧は未だ規定値以下になっていないのでＳ５からＳ６に進み、そこでバルブＳＶ２を開けてから規定時間だけ待ち、その間に検出ガス圧が規定値以下になったらＳ12でバルブＳＶ２を閉じ、再度Ｓ１～Ｓ４のステップを繰り返す。そして、このＳ１～Ｓ４のステップを繰り返している途中でＳ２において検出圧力が規定

値以下になったときはＳ13に進む。Ｓ２において検出ガス圧が規定値以下になることなくＳ１～Ｓ４のステップを繰り返していると、今だ水素ガス循環ポンプＧＰは作動していないのでそのうち水素ガスを燃料電池２内に放出し得なくなり、バルブＳＶ２を開けた後規定時間を経過しても圧力が規定値以下にならなくなる。そうすると、Ｓ６からＳ７に進み、そこでバルブＳＶ３を開き、Ｓ８で圧力センサＰＳ１の検出ガス圧が規定値以下になるまで待ち、規定値以下になったらＳ９でバルブＳＶ３を閉じ、Ｓ10でＳ１～Ｓ９のステップの実行回数が規定回数に達したか否かを判断し、達していなければＳ12でバルブＳＶ２を閉じてＳ１に戻り、再度Ｓ１～Ｓ９を繰り返し、その途中でＳ２において検出ガス圧が規定値以下になったらＳ13に進み、Ｓ２で検出ガス圧が規定値以下になることなくＳ１～Ｓ９の繰り返し回数が規定回数に達したら、Ｓ11で起動プロセスを停止する。

【００５１】次に、図６のＱ５に示すガス洩れチェックについて説明する。前述の様に、供給ガス圧チェックによりガス圧正常と判断されたらバルブＳＶ２，ＳＶ２′を開き、ガス洩れチェックを行なう。このガス洩れチェックは、前述の流量センサＦＳ，ＦＳ′によって行なう。即ち、バルブＳＶ２，ＳＶ２′を開けた直後は水素ガスおよび酸素ガスは燃料電池２内に向けて流れるが、この時点では未だガス循環ポンプＧＰ，ＧＰ′は作動していないので、ある程度水素ガスおよび酸素ガスが流れると燃料電池２内の水素ガスおよび酸素ガスの圧力は上昇して上記圧力レギュレータＰＲ，ＰＲ′により調整された圧力に近づき、以後は燃料電池２に向けて殆んど流れなくなる。しかるに、このとき燃料電池２に破損等によるガス洩れが生じていると、水素ガスおよび酸素ガスは引き続き燃料電池２に向けて所定量流れ続ける。

【００５２】そこで、上記バルブＳＶ２と燃料電池２との間に設けた流量センサＦＳ，ＦＳ′によりガス流量を検出し、バルブＳＶ２，ＳＶ２′を開けた時点から規定時間経過後の検出流量が規定値以上のときはガス洩れあり、規定値より小のときはガス洩れなしと判断し、水素ガスおよび酸素ガスのいずれかのガス洩れありのときは起動プロセスを停止し、いずれもガス洩れなしのときは次の漏電チェックに移行する。

【００５３】次に、図６のＱ６に示す漏電チェックについて説明する。漏電チェックは冷却水を通して漏電するか否かをチェックするものであり、この漏電チェックは冷却水の電気導電率を前述の導電率センサＣＳにより検出し、導電率が規定値以上のときは冷却水を通って漏電する虞れありということで起動を停止し、規定値より小のときは漏電の虞れなしということで次の電圧チェックに移る。

【００５４】次に図６のＱ９に示す電圧チェックについて説明する。前述の様に、起動時には作動停止時における残留ガスの反応による生成水がプロトン交換膜に付着し、正常な反応発電が妨げられる場合が生じ得る。従って、起動時に燃料電池２が正常に発電しているか否かをチェックし、正常発電が行なわれないときは起動を停止する。なお、この正常発電が行なわれない原因としては、上記プロトン交換膜への水付着以外にも、燃料電池の破損、プロトン交換膜や電極劣化等の種々の燃料電池自体の故障が考えられ、上記電圧チェックにより水付着によるトラブルのみでなくその様な燃料電池自体の故障も検出でき、それに応じて起動を停止させることができるものである。

【００５５】この電圧チェックの手順を、図９を参照しながら説明する。まず、Ｔ１でガス循環ポンプＧＰ，ＧＰ′を作動させる（図６のＱ８参照）。次に、Ｔ２で電圧チェックを行なう。この電圧チェックは、前述の電圧センサＶＳにより燃料電池２の各発電セル２もしくは複数の発電セル８から成る複数の発電セルグループそれぞれの電圧を検出し、それらの電圧のいずれもが規定値（本来正常に発電したらなるであろう電圧に基づいて決定される）以上であれば電圧正常、いずれかが規定値より小であれば電圧異常と判断する。そして、電圧が異常、即ちいずれかが規定値にまで達しなければＴ３で規定時間経過するまで待ち（電圧の立ち上りに所定時間要することがあるから）、規定時間経過する前に全ての電圧が規定値以上となり電圧正常と判断したらＴ５に進み、起動プロセスを終了し、以後はそのまま燃料電池の作動を続行して通常作動に移行する。また、所定時間経過してもいずれかの電圧が規定値に達しなければ、電圧異常と判断してＴ４に進み起動プロセスを停止する。

【００５６】図10は他の電圧チェック手順を示す図である。上述の手順は、ガス循環ポンプＧＰ，ＧＰ′を作動させて規定時間待ち、それでも電圧が規定値に達しなかったときには起動を停止するものであるので、上記ガス循環ポンプＧＰ，ＧＰ′の作動によるガス流によりある程度付着水が除去されたがそれでも付着水が残っている場合にはそのまま起動停止となるが、それらの付着水は基本的に除去可能なものであり、従ってその様な付着水の除去を行なった後においても電圧が異常である場合にのみ起動停止とすれば、付着水による起動停止を減少させることができると共に真に除去不可能な付着水による電圧異常の場合にのみ起動停止とすることができ、好都合である。

【００５７】図６はかかる付着水除去を組み込んだ電圧チェック手順を示す図である。図示の如くまずＵ１でガス循環ポンプＧＰ，ＧＰ′を作動させ、Ｕ２でＴ２と同様の電圧チェックを行ない、Ｕ３で規定時間経過するまで待ち、規定時間経過前に発電電圧が正常と判断されたらＵ８に進み起動プロセスを終了する。ここまでは図９に示す手順のＴ１，Ｔ２，Ｔ３，Ｔ５と同じである。

【００５８】次に、規定時間経過しても発電電圧が正常にならないときは、Ｕ４で水滴除去プロセス（付着水除

去制御）を実行する。この水滴除去プロセスは、例えばガス流量の増大もしくはガス流量の増減変化により行なうことができる。ガス流量の増大は、酸素ガスおよび水素ガス循環路56，66上のパージバルブＳＶ５′，ＳＶ５を開放することにより燃料電池２内の酸素ガスおよび水素ガスを一気に排出し、それにより瞬間的にであるがガス流量を増大させる方法あるいは酸素ガス循環ポンプＧＰ′および水素ガス循環ポンプＧＰの流量を増大させる方法により実行することができる。ガス流量の増減変化は、例えば上記酸素ガス循環ポンプＧＰ′および水素ガス循環ポンプＧＰのオン・オフを繰り返すことにより、あるいは酸素ガスおよび水素ガス循環路56，66上に設けた前述の循環路開閉バルブＳＶ４′，ＳＶ４の開閉を繰り返すことにより実行することができる。

【００５９】上記水滴除去プロセスを実行しつつＵ５でＴ５と同様の電圧チェックを行ない、電圧が正常になれば水滴除去プロセスを終了してＵ８に進み、起動プロセスを終了する。Ｕ５で電圧が正常と判断されないときはＵ６で水滴除去プロセスが規定回数もしくは規定時間行なわれたか否かを判断し、規定回数もしくは規定時間水滴除去プロセスが行なわれても発電電圧が正常にならなかった場合にのみ、Ｕ７で起動プロセスを停止する。

【００６０】上記図９，10に示す実施例においては、発電電圧の正常異常を、各発電セルの発電電圧もしくは各発電セルグループの発電電圧が規定値以上か否かによって判断しているが、各発電セル内の発電電圧のばらつき（例えば最大値と最小値との差分）もしくは各発電セルグループ間の発電電圧（発電セルグループの発電電圧はその発電セルグループ内の発電セルの発電電圧の総和）のばらつきが規定値以上（電圧異常）か規定値より小（電圧正常）かによって判断することができるし、また各燃料電池自身の発電電圧（燃料電池内の各発電セルの発電電圧の総和）が規定値以上（電圧正常）が規定値より小（電圧異常）かによって判断することもできる。

【００６１】なお、前述の様に発電電圧の異常原因は付着水のみでなく燃料電池の故障も考えられ、上記図９に示す手順ではその発電電圧の異常原因がいずれかを判別することはできず、付着水の場合は基本的に除去可能でありかつ除去して起動することが望ましいものであるにも拘らず、その様な付着水による場合も一律に起動停止とされる。しかしながら、上記図10に示す手順によれば、その様な付着水による電圧異常に基づく起動停止の

殆んどは回避でき、基本的にその場では直ちに解決不可能な燃料電池自体の故障による電圧異常のときのみ起動停止とすることができるので好都合である。

【００６２】また、上記実施例では付着水除去に関して水素ガス側と酸素ガス側とを同様に構成しているが、付着水の問題は特に酸素室において発生する反応生成水のウエイトが大きく、従って上記の余剰電力によるガス循環ポンプの作動やガス流量の増大もしくは増減変化による付着水除去制御は酸素ガス側にのみ施すことも可能である。

【図面の簡単な説明】

【図１】本発明に係る燃料電池自動車における燃料電池システムの一実施例を示す図

【図２】図１中の燃料電池を示す図

【図３】図２中の燃料電池における水素ガス、酸素ガスおよび冷却水の流れを示す図

【図４】図２中の燃料電池の発電部の構成および酸素ガスの流れを示す断面図

【図５】燃料電池システムの作動停止手順の一例を示すフローチャート

【図６】燃料電池システムの起動手順の一例を示すフローチャート

【図７、図８】それぞれ供給ガス圧チェック手順の一例を示すフローチャート

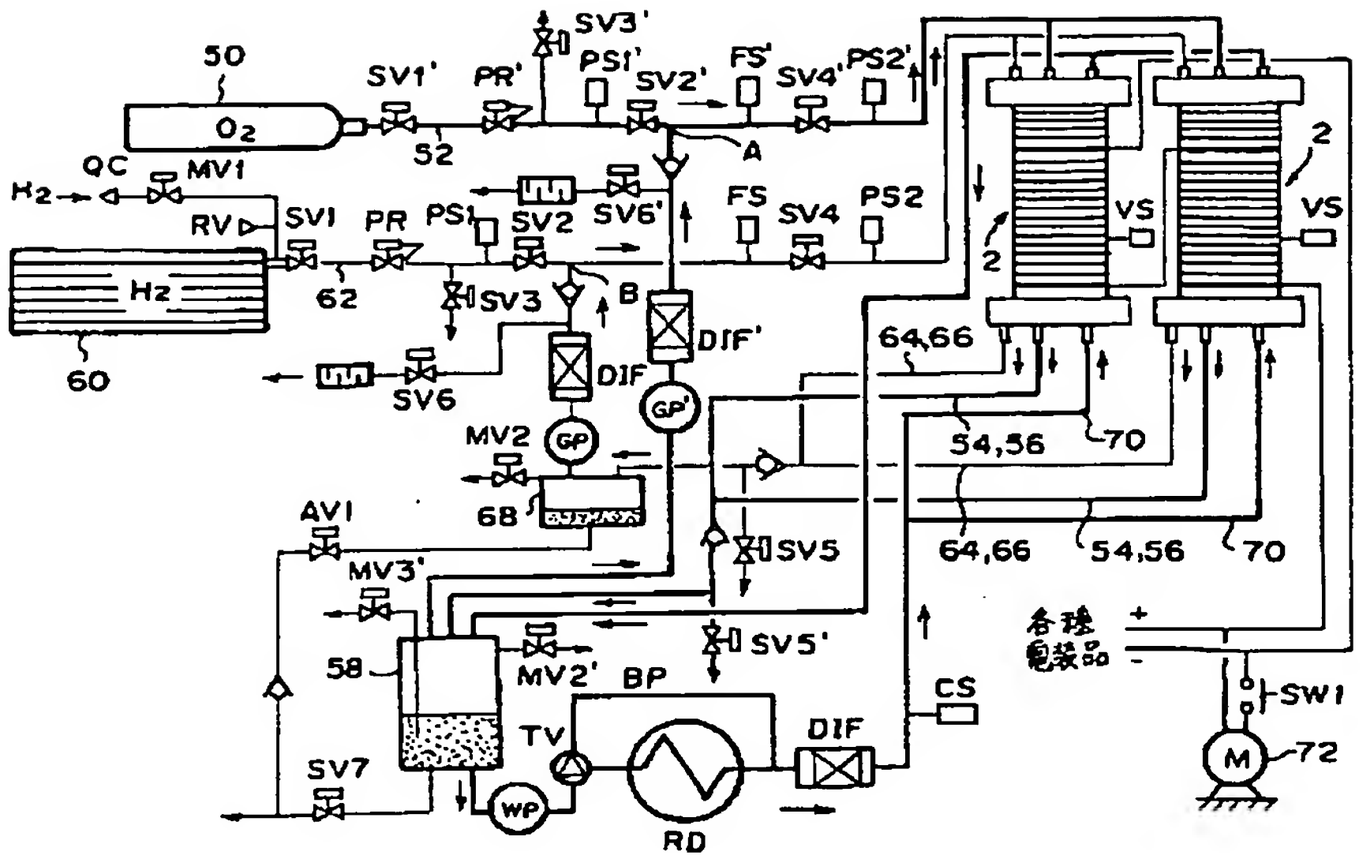
【図９、図１０】それぞれ発電電圧チェック手順の一例を示すフローチャート

【図１１、図１２】従来の燃料電池の配設態様を示す図

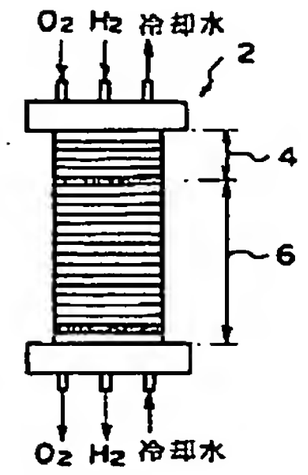
【符号の説明】

2　燃料電池
6　発電部
8　発電セル
20　酸素ガス通路
30　水素ガス通路
50　酸素ガス供給源
56　酸素ガス循環路
60　水素ガス供給源
66　水素ガス循環路
72　走行用モータ
ＧＰ　水素ガス循環ポンプ
ＧＰ′　酸素ガス循環路ポンプ
ＶＳ　電圧センサ

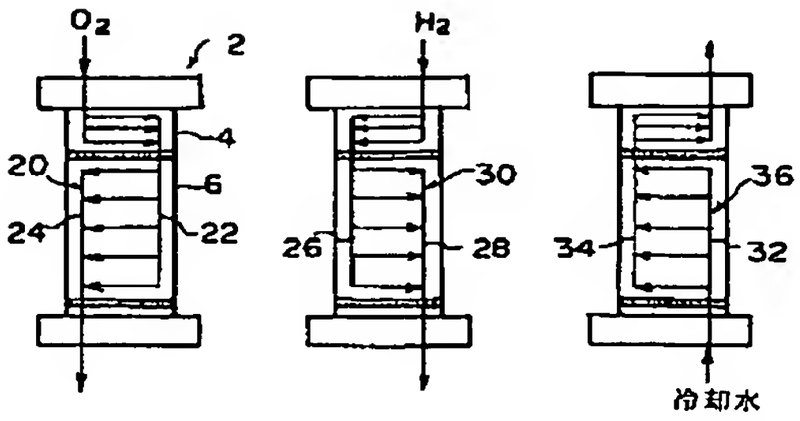
【図１】



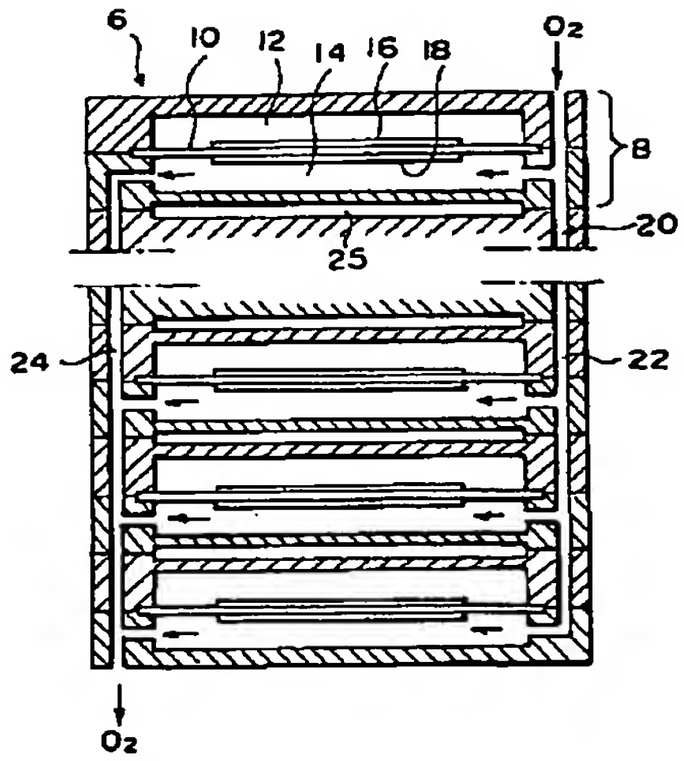
【図２】



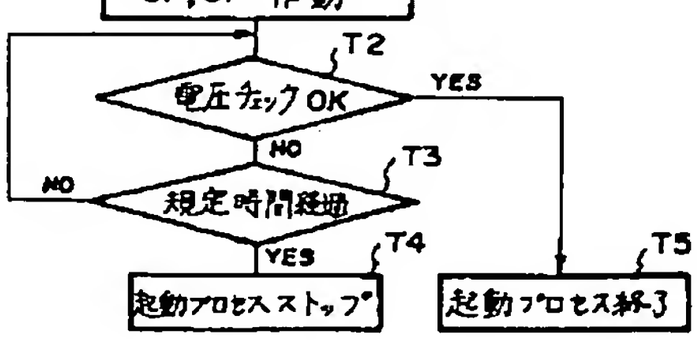
【図３】



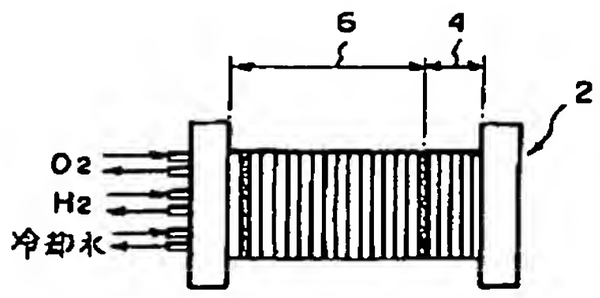
【図４】



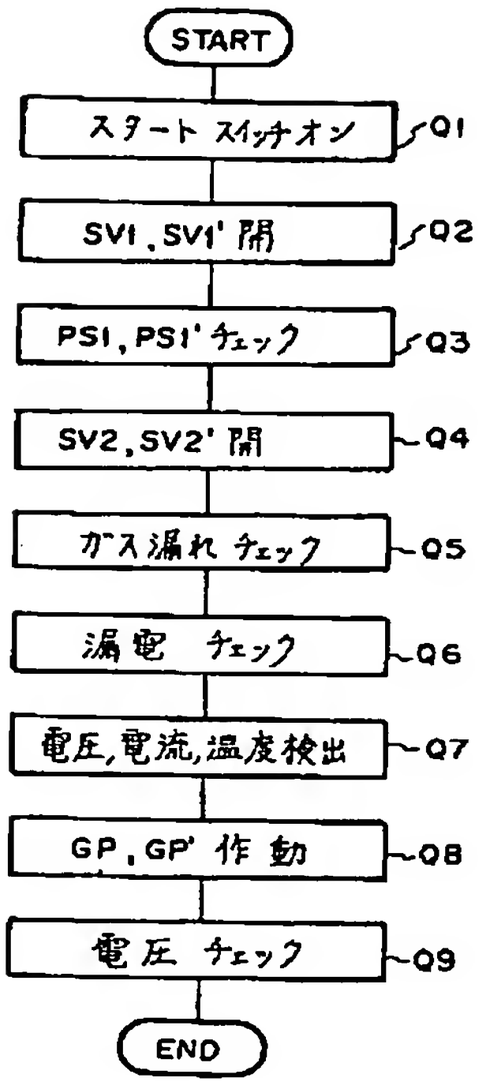
【図９】



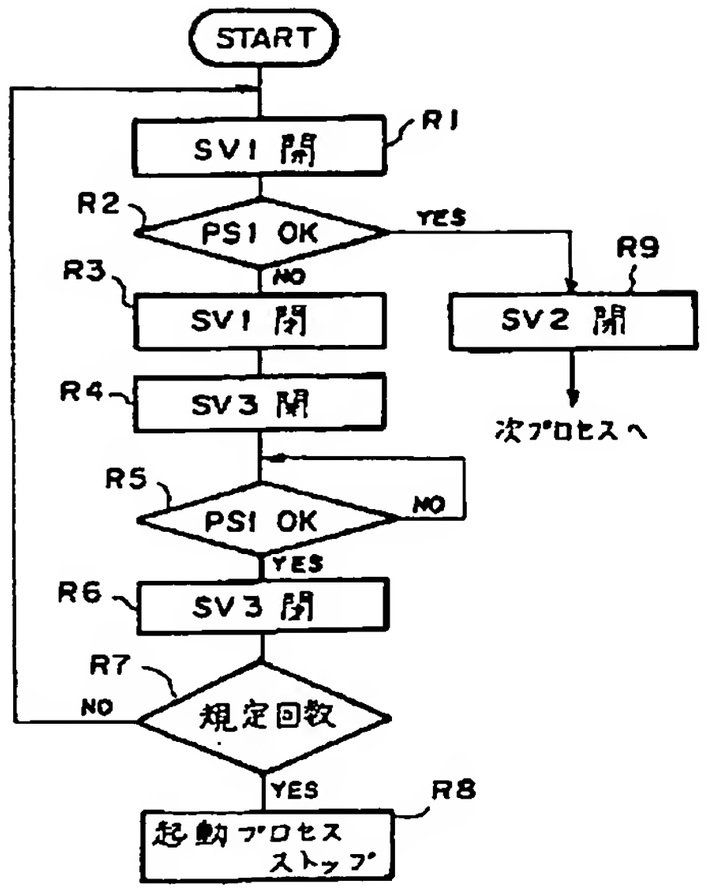
【図１１】



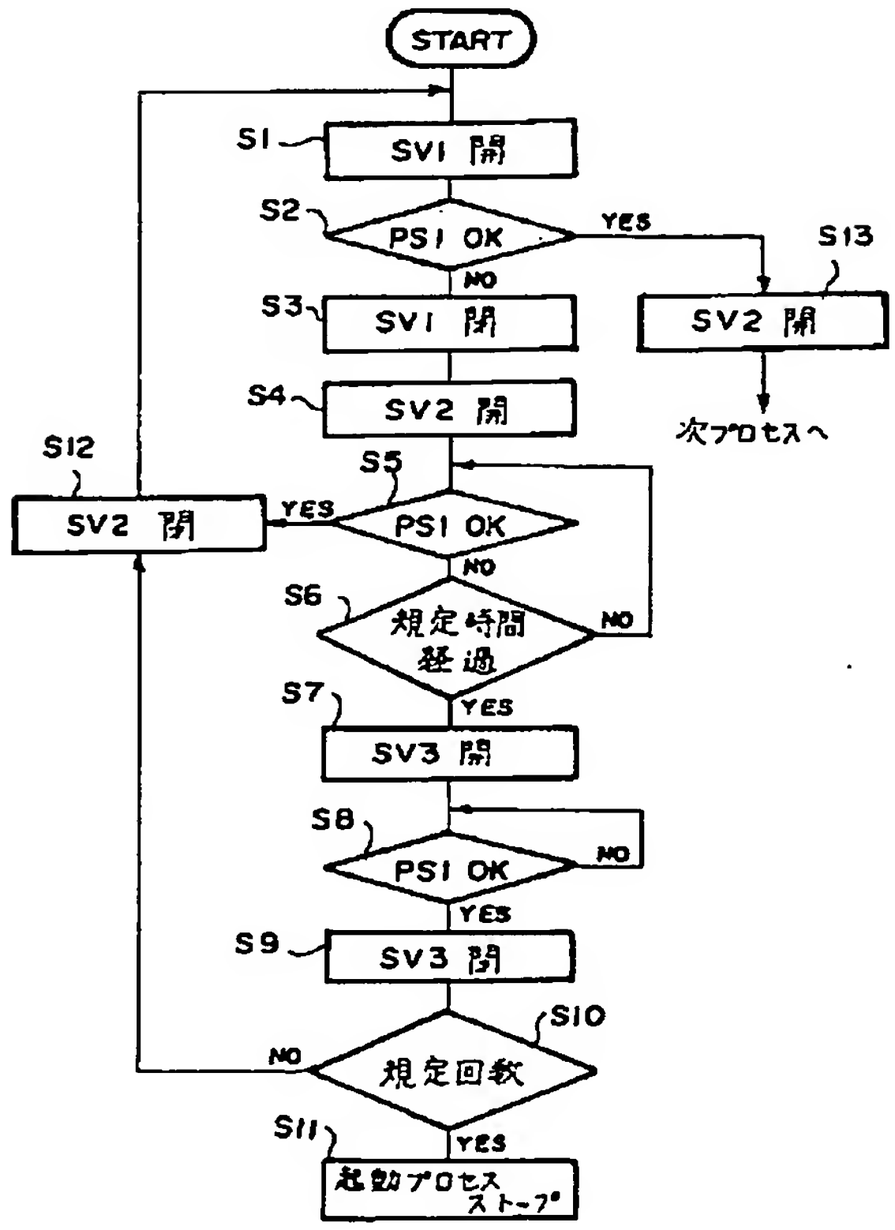
【図６】


START
スタート スイッチオン
Q1
SV1,SV1' 開
Q2
PS1,PS1' チェック
Q3
SV2,SV2' 開
Q4
ガス漏れ チェック
Q5
漏電 チェック
Q6
電圧,電流,温度検出
Q7
GP,GP' 作動
Q8
電圧 チェック
Q9
END

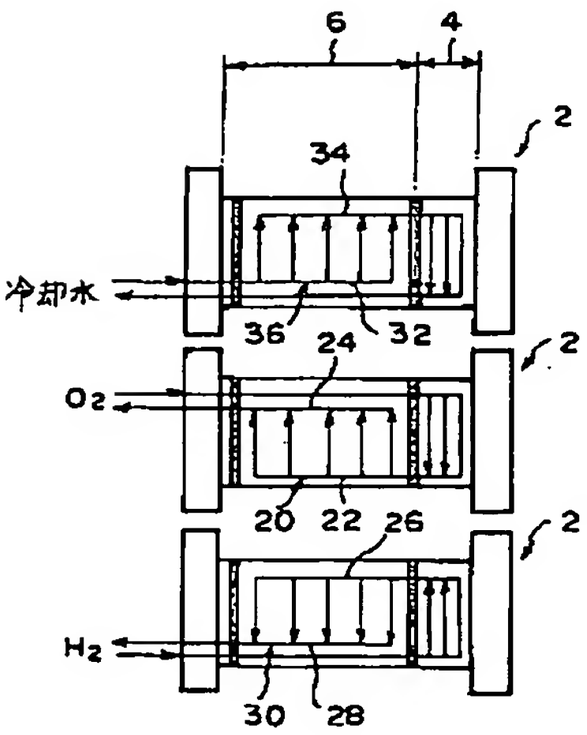
【図７】


START
SV1 開
R1
R2
PS1 OK
YES
NO
R9
SV2 開
次プロセスへ
R3
SV1 閉
R4
SV3 開
R5
PS1 OK
NO
YES
R6
SV3 閉
R7
NO
規定回数
YES
R8
起動プロセス
ストップ

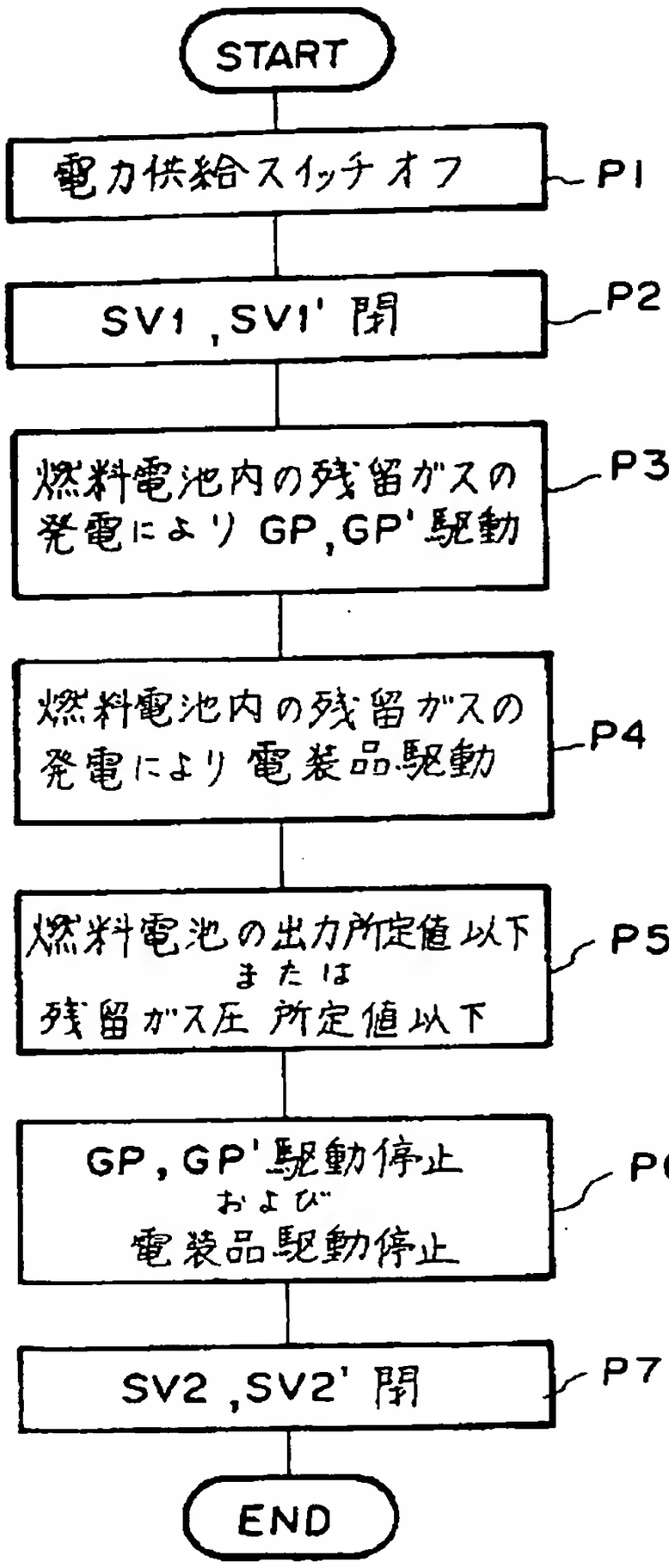
【図８】


START
S1
SV1 開
S2
PS1 OK
YES
NO
S13
SV2 開
次プロセスへ
S3
SV1 閉
S4
SV2 開
S12
SV2 閉
S5
YES
PS1 OK
NO
S6
規定時間
経過
NO
YES
S7
SV3 開
S8
PS1 OK
NO
YES
S9
SV3 閉
S10
NO
規定回数
YES
S11
起動プロセス
ストップ

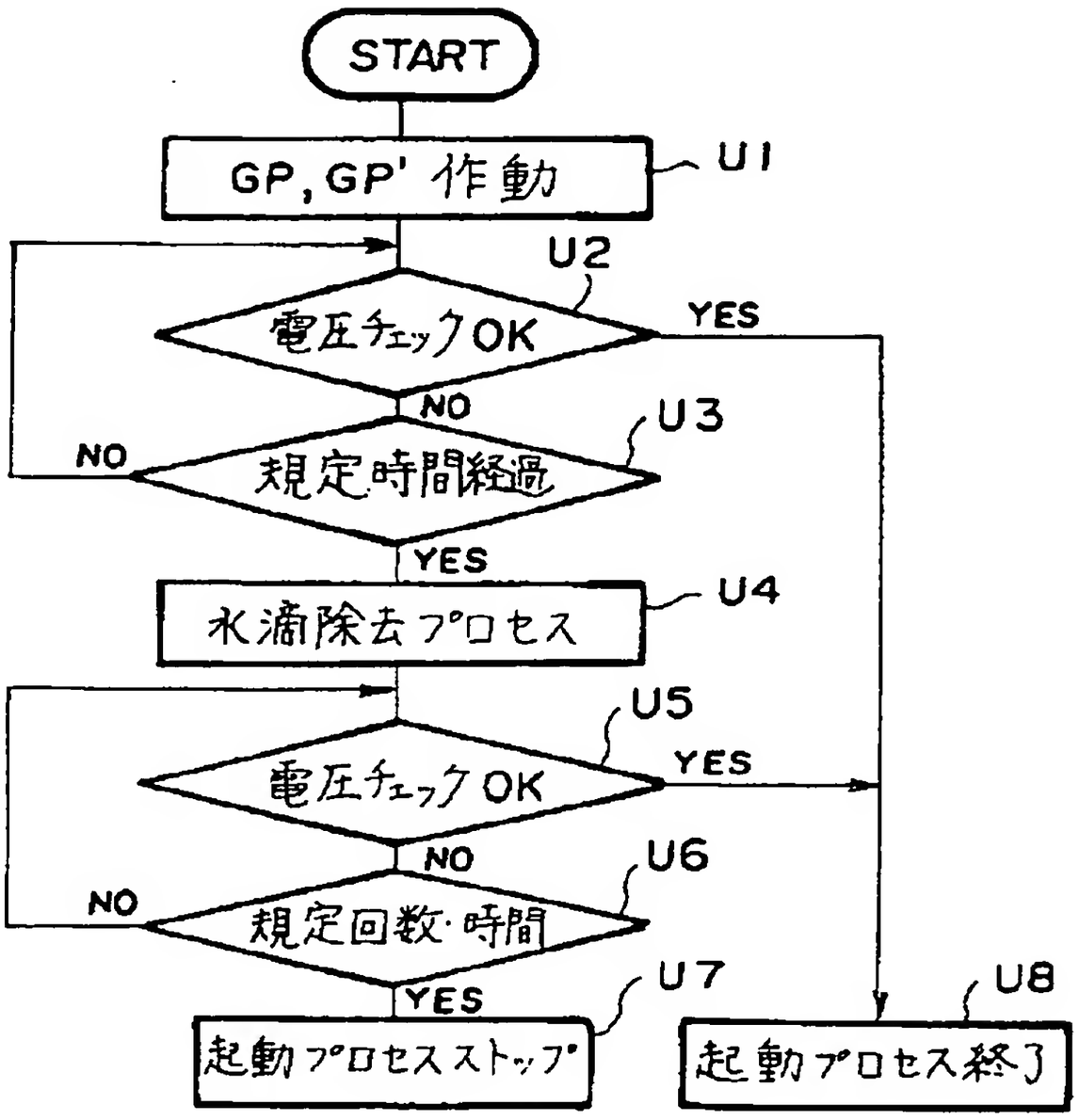
【図１２】


6
4
2
34
冷却水
36
24
32
O2
2
20
22
26
2
H2
30
28

【図５】


START
電力供給スイッチオフ
P1
SV1 ,SV1' 閉
P2
燃料電池内の残留ガスの
発電により GP,GP' 駆動
P3
燃料電池内の残留ガスの
発電により電装品駆動
P4
燃料電池の出力所定値以下
または
残留ガス圧 所定値以下
P5
GP,GP' 駆動停止
および
電装品駆動停止
P6
SV2 ,SV2' 閉
P7
END

【図１０】



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特開　昭61－32362（ＪＰ，Ａ）
特開　平３－159073（ＪＰ，Ａ）

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